WTCI-129-P

15 world trade center

Operation & Maintenance

HVAC system towers A & B

OUTSIDE AIR TEMP. ______ SUPPLY FAN DESIGN DISCH. TEMP.

FAN NUMBER	ZONE	SERVICE	ON	OFF	DISCH. TEMP.	COMMENT
ACS-S5-1	SUBGRADE	N.Y. STATE SUPPLY 284 LEVEL				
ACS-S5-2	SUBGRADE	SUBGRADE & TOWER "B" SUPPLY FAN				
ACS-S5-3	SUBGRADE	SUBSTATION AND PUMP ROOM SUPPLY				
ACS-S5-4	SUBGRADE	LOADING DOCK SUPPLY FAN				
ACS-S5-5	SUBGRADE	SUBGRADE CONTROL ROOM SUPPLY FAN				
ACS-S5-6	SUBGRADE	N.Y. STATE SUPPLY FAN 294 LEVEL				
ACS-S5-7	SUBGRADE	N.Y. STATE SUPPLY FAN 274 LEVEL				
VS-S5-1	SUBGRADE	GARAGE MAKEUP VENTILATION				
VS-S5-2	SUBGRADE	SUBGRADE STORAGE VENTILATION				
VS-S5-3	SUBGRADE	M.E.R. VENTILATION 242 LEVEL				
VS-S5-4		PATH SERVICE SOUTH				
VS-S5-5	SUBGRADE	SUBGRADE AND TOWER "B" VENTILATION				
VS-S5-6	SUBGRADE	SUBGRADE STORAGE VENTILATION				
ACR-S5-1	SUBGRADE	N.Y. STATE RETURN 284 LEVEL				
ACR-S5-2	SUBGRADE	BUILDING SERVICES RETURN FAN				
ACR-S5-3	SUBGRADE	SUBSTATION AND PUMP ROOM RETURN				
ACR-S5-4	SUBGRADE	LOADING DOCK RETURN FAN				
ACR-S5-5	SUBGRADE	SUBGRADE CONTROL ROOM RETURN				
ACR-S5-6	SUBGRADE	N.Y. STATE RETURN 294 LEVEL				
ACR-S5-7	SUBGRADE	N.Y. STATE RETURN 274 LEVEL				
T-S1-1		GARAGE TRANSFERE FAN				
T-S3-1		EAST GARAGE TRANSFERE FAN 279 LEVEL				
T-S3-2		EAST GARAGE TRANSFERE FAN 279 LEVEL				
E-S5-1		M.E.R. EXHAUST FAN 242 LEVEL				

AIR COMPRESSOR #1 ON/ OFF/ AIR COMPRESSOR #2 ON/ OFF/ AIR COMPRESSOR #3 ON/ O

DRIER "A" ON/ OFF/ DRIER "B" ON/ OFF/

CONDENSATE PUMPS

PUMP NUMBER	LE.	LAG.	COMMENTS
CP-S5-1A			
CP-S5-1B			

HONEYWELL AIR STATION PRESSURE:__________

TELEPHONE__________

M.E.R. DOOR LOCKS__________

M.E.R. STEAM DISCHARGE PRESSURE:__________

COMMENTS

GARBAGE PICK-UP REQUIRED: YES____ NO____ ENGINEER__________

DATE: / /   M.E.R. #5 TOWER "B" 242 LEVEL   WATCH:__________

COMPUTER COOLING SYSTEM 269 LEVEL TOWER A & 284 'B'			PUMP PRESSURE		AUX. COOLING WATER TEMP.		& RIVER WATER TEMP.		COOLER PRESSURES RIV. WAT. SIDE			AUX. WAT. SIDE		
ACW SYSTEM 1	ON	OFF	SUCT.	DISCH.	IN	OUT	IN	OUT	IN	OUT	DIF.	IN	OUT	DIF.
ACWP-S3-S1														
ACWP-S3-S2														
ACW SYSTEM 3	ON	OFF	SUCT.	DISCH.	IN	OUT	IN	OUT						
ACWP-S3-S3														
ACWP-S3-S4														
									PRIMARY SIDE			SECONDARY SIDE		
ACW SYSTEM 5	ON	OFF	SUCT.	DISCH.	IN	OUT			IN	OUT	DIF.	IN	OUT	DIF.
ACWP-B-1														
ACWP-B-2														

7th FLOOR M.E.R. TOWER "B"

FAN NUMBER	ZONE	SERVICE	ON	OFF	SPACE SENSOR READING °F 9:00 AM	11:30 PM	2:30 PM
ACS-7-1	NORTH	PERIPHERAL 9-24th FLOOR					
ACS-7-2	EAST	PERIPHERAL 9-24th FLOOR					
ACS-7-3	SOUTH	PERIPHERAL 9-24th FLOOR					
ACS-7-4	WEST	PERIPHERAL 9-24th FLOOR					
ACS-7-5	SOUTHWEST	INTERIOR AIR 9-24th FLOOR					
ACS-7-6	NORTHWEST	INTERIOR AIR 9-24th FLOOR					
ACS-7-7	NORTHEAST	INTERIOR AIR 9-24th FLOOR					
ACS-7-8	SOUTHEAST	INTERIOR AIR 9-24th FLOOR					
ACS-7-9		CORE 2nd-6th FLOOR					
ACS-7-10	NORTHSOUTH	CORE 9-24th FLOOR					
ACS-7-11	SOUTHWEST	LOBBY 2nd FLOOR					
ACS-7-12	NORTHEAST	LOBBY 2nd FLOOR					
ACS-7-13		LOBBY INTERIOR 2nd FLOOR					
ACS-7-14		LOBBY CONCOURSE 1st FLOOR					
ACR-7-1	SOUTHWEST	RETURN AIR 9-24th FLOOR					
ACR-7-2	SOUTHWEST	RETURN AIR 9-24th FLOOR					
ACR-7-3	NORTHWEST	RETURN AIR 9-24th FLOOR					
ACR-7-4	NORTHWEST	RETURN AIR 9-24th FLOOR					
ACR-7-5	NORTHEAST	RETURN AIR 9-24th FLOOR					
ACR-7-6	NORTHEAST	RETURN AIR 9-24th FLOOR					
ACR-7-7	SOUTHEAST	RETURN AIR 9-24th FLOOR					
ACR-7-8	SOUTHEAST	RETURN AIR 9-24th FLOOR					
ACR-7-9		CORE RETURN 2-6th FLOOR					
ACR-7-10	EAST&SOUTH	LOBBY RETURN PLAZA					
ACR-7-11	NORTH&EAST	LOBBY RETURN RETURN					
ACR-7-12		LOBBY INTERIOR RETURN					
ACR-7-13		LOBBY RETURN CONCOUSE					
E-7-14	SOUTH	TOILET EXHAUST 9-24th FL.					
E-7-15	NORTH	TOILET EXHAUST 9-24th FL.					
E-7-16		TOILET EXH. BELOW 1st FL.					
E-7-17		LOCAL ELEV. M.R. EXHAUST					
E-7-18	SOUTH	M.E.R. EXHAUST					
E-7-19	NORTH	M.E.R. EXHAUST					
E-7-20	WEST	ELECT. SUB-STATION EXHAUST					
E-7-21	EAST	ELECT. SUB STATION EXHAUST					

SECURITY SYSTEMS CHECKLIST

MER DOORS F.E. SECURITY

Stair A_____ 5 Car_______

" B_____ 50 " _______

" C_____ 48 "

SETBACK NW_____

SE_____

CODE

✓ ALL OK

X NG (See Remarks)

GARBAGE PICK UP REQUIRED:YE

TELEPHONE__________

REMARKS (List Deficiencies)

@ 9:00 A. M.

PUMP NUMBER	SERVICE	ON	OFF	SUCTION PRESS	DISCH. PRESS.	TEMP. IN	TEMP. OUT	PRESSURE IN	PRESSURE OUT	COMME
P-7-1	N.W. SEC. 9-24th FL.									
P-7-2	STANDBY									
P-7-3	S.E. SEC. 9-24th FL.									
P-7-4	STANDBY									
P-7-5	INTERIOR REHEAT 9-24									
P-7-6	STANDBY									

HONEYWELL AIR STATION PRESSURES: N.W._____ N.E._____ S.W._____ S.E._____

DOMESTIC HOTWATER TEMP.__________ M.E.R. STEAM DISCHARGE PRESS.__________

TELEPHONE______________ M.E.R. DOOR LOCKS______________

ENGINEER______________

DATE / / TOWER "B" 7th FLOOR M.E.R. WATCH:______________

...UTSIDE ... SUPPLY FAN DISCHARGE TEMP.-DESIGN______

41st FLOOR M.E.R. TOWER "B"

FAN NUMBER	ZONE	SERVICE	ON	OFF	DISCH. TEMP.	SPACE TEMP.	COMMEN
ACS-41-1	NORTH	PERIPHERAL 25-58th FLOOR				UP: DOWN:	
ACS-41-2	EAST	PERIPHERAL 25-58th FLOOR				UP: DOWN:	
ACS-41-3	SOUTH	PERIPHERAL 25-58th FLOOR				UP: DOWN:	
ACS-41-4	WEST	PERIPHERAL 25-58th FLOOR				UP: DOWN:	
ACS-41-5	SOUTHWEST	INTERIOR 25-40th FLOOR					
ACS-41-6	NORTHWEST	INTERIOR 25-40th FLOOR					
ACS-41-7	NORTHEAST	INTERIOR 25-40th FLOOR					
ACS-41-8	SOUTHEAST	INTERIOR 25-40th FLOOR					
ACS-41-9	SOUTHWEST	INTERIOR 44-58th FLOOR					
ACS-41-10	NORTHWEST	INTERIOR 44-58th FLOOR					
ACS-41-11	NORTHEAST	INTERIOR 44-58th FLOOR					
ACS-41-12	SOUTHEAST	INTERIOR 44-58th FLOOR					
ACS-41-13	SOUTH	CORE 25-58th FLOOR					
ACS-41-14	NORTH	CORE 25-58th FLOOR					
ACS-41-15	SOUTH	SHUTTLE ELEV. M.R. 47th Fl					
ACS-41-16	NORTH	SHUTTLE ELEV. M.R. 41&47					
ACR-41-1	SOUTHWEST	RETURN 25-58th FLOOR					
ACR-41-2	SOUTHWEST	RETURN 25-58thFLOOR					
ACR-41-3	SOUTHWEST	RETURN 25-58th FLOOR					
ACR-41-4	NORTHWEST	RETURN 25-58th FLOOR					
ACR-41-5	NORTHWEST	RETURN 25-58th FLOOR					
ACR-41-6	NORTHWEST	RETURN 25-58th FLOOR					
ACR-41-7	NORTHEAST	RETURN 25-58th FLOOR					
ACR-41-8	NORTHEAST	RETURN 25-58th FLOOR					
ACR-41-9	NORTHEAST	RETURN 25-58th FLOOR					
ACR-41-10	SOUTHEAST	RETURN 25-58th FLOOR					
ACR-41-11	SOUTHEAST	RETURN 25-58th FLOOR					
ACR-41-12	SOUTHEAST	RETURN 25-58th FLOOR					
E-41-13	SOUTH	TOILET EXHAUST 25-58th FL.					
E-41-14	NORTH	TOILET EXHAUST 25-58th FL.					
E-41-15	SOUTH	LOCAL ELEV. M.R. EXHAUST					
E-41-16	NORTH	LOCAL ELEV. M.R. EXHAUST					
E-41-17		SHUTTLE ELEV. M.R. 41&47					
E-41-18	SOUTH	M.E.R. EXHAUST					
E-41-19	NORTH	M.E.R. EXHAUST					
E-41-20	WEST	ELECT. SUB-STATION EXHAUST					
E-41-2-	EAST	ELECT. SUB-STATION EXHAUST					

SECURITY SYSTEMS CHECKLIST

MER DOORS
Stair A ___
" B ___
" C ___

F.E. SECURITY CAGE
6 Car______
50" ______

SETBACK NW ___
SE ___

CODE
√ All O.K.
X NG See Rem

GARBAGE PICK-UP REQUIRED: YES__ N
TELEPHONE____________

REMARKS: LIST DEFICIENCIES

PUMP NUMBER	SERVICE	ON	OFF	PUMPS SUCTION PRESS.	DISCH. PRESS.	HEAT EXCHANGERS TEMP. IN	OUT	PRESSURE IN	OUT	COMMENTS
P-41-1	N.W. Sec. 25-40									
P-41-2	STANDBY									
P-41-3	S.E. Sec. 25-40									
P-41-4	STANDBY									
P-41-5	N.W. Sec. 43-58									
P-41-6	STANDBY									
P-41-7	S.E. Sec. 43-58									
P-41-8	STANDBY									
P-41-9	INTERIOR REHEAT									
P-41-10	STANDBY 25-40									
P-41-11	INTERIOR REHEAT									
P-41-12	STANDBY 43-58									

HONEYWELL AIR STATION - N.W._____ N.E._____ S.W._____ S.E._____
PRESSURES:

DOMESTIC HOTWATER TEMP. - UPFEED______ DOWNFEED______ M.E.R. STEAM DISCHARGE PRESS.______

TELEPHONE______________ M.E.R. DOOR LOCKS______________

COMMENTS

GARBAGE PICK-UP REQUIRED: YES____ NO____ ENGINEER______________

TOWER "B" 41st FLOOR M.E.R. DATE______

SPACE SENSOR READ...

FAN NUMBER	ZONE	SERVICE	ON	OFF	9:00 AM U	9:00 AM D	11:30 AM U	11:30 AM D	2:30 PM U	2:30 PM D	4...
ACS-75-1	NORTH	PERIPHERAL 59-91st FLOOR									
ACS-75-2	EAST	PERIPHERAL 59-91st FLOOR									
ACS-75-3	SOUTH	PERIPHERAL 59-91st FLOOR									
ACS-75-4	WEST	PERIPHERAL 59-91st FLOOR									
ACS-75-5	SOUTHWEST	INTERIOR AIR 59-74th FLOOR									
ACS-75-6	NORTHWEST	INTERIOR AIR 59-74th FLOOR									
ACS-75-7	NORTHEAST	INTERIOR AIR 59-74th FLOOR									
ACS-75-8	SOUTHEAST	INTERIOR AIR 59-74th FLOOR									
ACS-75-9	SOUTHEAST	INTERIOR AIR 77-91st FLOOR									
ACS-75-10	NORTHWEST	INTERIOR AIR 77-91st FLOOR									
ACS-75-11	NORTHEAST	INTERIOR AIR 77-91st FLOOR									
ACS-75-12	SOUTHEAST	INTERIOR AIR 77-91st FLOOR									
ACS-75-13	SOUTH	CORE 59-91st FLOOR									
ACS-75-14	NORTH	CORE 59-91st FLOOR									
ACS-75-15	SOUTH	SHUTTLE ELEV. M.R. 81st FL.									
ACS-75-16	NORTH	SHUTTLE ELEV.M.R. 75-76-81									
ACR-75-1	SOUTHWEST	RETURN AIR 59-91st FLOOR									
ACR-75-2	SOUTHWEST	RETURN AIR 59-91st FLOOR									
ACR-75-3	SOUTHWEST	RETURN AIR 59-91st FLOOR									
ACR-75-4	NORTHWEST	RETURN AIR 59-91st FLOOR									
ACR-75-5	NORTHWEST	RETURN AIR 59-91st FLOOR									
ACR-75-6	NORTHWEST	RETURN AIR 59-91st FLOOR									
ACR-75-7	NORTHEAST	RETURN AIR 59-91st FLOOR									
ACR-75-8	NORTHEAST	RETURN AIR 59-91st FLOOR									
ACR-75-9	NORTHEAST	RETURN AIR 59-91st FLOOR									
ACR-75-10	SOUTHEAST	RETURN AIR 59-91st FLOOR									
ACR-75-11	SOUTHEAST	RETURN AIR 59-91st FLOOR									
ACR-75-12	SOUTHEAST	RETURN AIR 59-91st FLOOR									
E-75-13	SOUTH	TOILET EXHAUST 59-91st FL.									
E-75-14	NORTH	TOILET EXHAUST 59-91st FL.									
E-75-15	SOUTH	LOCAL ELEV.M.R. EXHAUST									
E-75-16	NORTH	LOCAL ELEV.M.R. EXHAUST									
E-75-17	SOUTH	SHUTTLE ELEV.M.R. EXH. 81									
E-75-18	NORTH	SHUTTLE ELEV.M.R. EXH. 75-81									
E-75-19	SOUTH	M.E.R. EXHAUST									
E-75-20	NORTH	M.E.R. EXHAUST									
E-75-21	WEST	ELECT. SUB-STATION EXHAUST									
E-75-22	EAST	ELECT. SUB-STATION EXHAUST									

SECURITY SYSTEMS CHECKLIST

MER DOORS — F.E. SECURITY C...

Stair A____ 6 Car____

" B____ 50 Car____

" C____

SETBACK NE____ CODE

" SW____ ✓ O.K

XNG (See r...

GARBAGE PICK-UP REQUIRED: YE...

TELEPHONE____

REMARKS: LIST DEFICIENCIES

@ 9:00 A. M.

PUMP NUMBER	SERVICE	ON	OFF	SUCTION PRESS.	DISCH. PRESS.	TEMP. IN	TEMP. OUT	PRESSURE IN	PRESSURE OUT	COMMEN...
P-75-1	SEC. N.W. 59-74									
P-75-2	STANDBY									
P-75-3	SEC. S.E. 59-74									
P-75-4	STANDBY									
P-75-5	SEC. N.W. 77-91									
P-75-6	STANDBY									
P-75-7	SEC. S.E. 77-91									
P-75-8	STANDBY									
P-75-9	INTERIOR REHEAT									
P-75-10	STANDBY 59-74									
P-75-11	INTERIOR REHEAT									
P-75-12	STANDBY 77-91									

HONEYWELL AIR STATION PRESSURES: N.W.____ N.E.____ S.W.____ S.E.____

DOMESTIC HOTWATER TEMP. UPFEED____ DOWNFEED____ M.E.R. STEAM DISCHARGE PRESS.____

COMMENTS

ENGINEER____

DATE __/__/__ TOWER 75th FLOOR M.E.R. "B" WATCH:____

FAN NUMBER	ZONE	SERVICE	ON	OFF	SPACE SENSOR READING °F 9:00 AM	11:30 AM	2:30 PM	4:30 P
ACS-108-1	NORTH	PERIPHERAL AIR 92-106 FL.						
ACS-108-2	EAST	PERIPHERAL AIR 92-106 FL.						
ACS-108-3	SOUTH	PERIPHERAL AIR 92-106 FL.						
ACS-108-4	WEST	PERIPHERAL AIR 92-106 FL.						
ACS-108-5	SOUTHWEST	INTERIOR AIR 92-106th FL.						
ACS-108-6	NORTHWEST	INTERIOR AIR 92-106th FL.						
ACS-108-7	NORTHEAST	INTERIOR AIR 92-106th FL.						
ACS-108-8	SOUTHEAST	INTERIOR AIR 92-106th FL.						
ACS-108-9	NORTH&SOUTH	CORE 92-106th FLOOR						
ACS-108-10		FRT.&SHUTTLE ELEV. M.R.						
ACS-108-11		PERIPHERAL 107th FLOOR						
ACR-108-1	SOUTHWEST	RETURN AIR 92-106th FL.						
ACR-108-2	SOUTHWEST	RETURN AIR 92-106th FL.						
ACR-108-3	NORTHWEST	RETURN AIR 92-106th FL.						
ACR-108-4	NORTHWEST	RETURN AIR 92-106th FL.						
ACR-108-5	NORTHEAST	RETURN AIR 92-106th FL.						
ACR-108-6	NORTHEAST	RETURN AIR 92-106th FL.						
ACR-108-7	SOUTHEAST	RETURN AIR 92-106th FL.						
ACR-108-8	SOUTHEAST	RETURN AIR 92-106th FL.						
E-108-9	NORTHSOUTH	TOILET EXHAUST 92-106th						
E-108-10		LOCAL ELEV. M.R. EXHAUST						
E-108-11	EXHAUST	FRT.&SHUTTLE ELEV. M.R.						
E-108-12	SOUTH	M.E.R. EXHAUST						
E-108-13	NORTH	M.E.R. EXHAUST						
E-108-14	WEST	ELECT. SUB-STATION EXH.						
E-108-15	EAST	ELECT. SUB-STATION EXH.						

SECURITY SYSTEM CHECKLIST

MER DOORS

Stair A____ Set Back NE____

C____ " " SW✓____

50 & 99 CAR FEL

Access Card Entrance____

Double Door Entrance____

Code

✓ All O.K.

X N.G. (See Remarks)

GARBAGE PICK-UP REQUIRED:YES__

TELEPHONE____

REMARKS: LIST DEFICIENCIES

@ 9:00 A. M.

PUMP NUMBER	SERVICE	ON	OFF	SUCT. PRESS	DISCH PRESS	TEMP. IN	TEMP. OUT	PRESSURE IN	PRESSURE OUT	COMMENTS
P-108-1	SEC. N.W. 92-106									
P-108-2	STANDBY									
P-108-3	SEC. S.E. 92-106									
P-108-4	STANDBY									
P-108-5	INTERIOR REHEAT									
P-108-6	STANDBY 92-106									
P-108-7	PERIPHERAL SEC.W.									
P-108-8	STANDBY 107th FL.									

HONEYWELL AIR STATION PRESSURES: N.W.____ N.E.____ S.W.____ S.E.____

DOMESTIC HOTWATER TEMP.____ M.E.R. STEAM DISCHARGE PRESS.____

COMMENTS

ENGINEER:____

DATE: / / TOWER"B" 108th FLOOR M.E.R. WATCH:____

4 WTC

OUTSIDE AIR TEMP. ________

CHILLED WATER--IN
AUX. CHILLED WATER -IN
--OUT

SOUTHEAST 285.6 MER AND AUXILLARY COOLING WATER

FAN NUMBER	ZONE	SERVICE	ON	OFF	DISCH. TEMP.	CONC. SP. TEMP.	COMMENTS
ACS-S2-1	SO. SECT WEST	INTERIOR SUPPLY FLOORS 3-7					
ACS-S2-2	SO.SECT WEST	INTERIOR SUPPLY FLOORS 3-7					
ACS-S2-3	SO.SECT.WEST	INTERIOR SUPPLY FLOORS 3-7					
ACS-S2-4	310 LEVEL	INT. PLAZA SUPPLY SYSTEM					
ACS-S2-5		1st FLOOR GALLERIA SUPPLY SY					
ACS-S2-6		1st FLOOR GALLERIA SUPPLY SY					
ACS-S2-7		1st FLOOR GALLERIA SUPPLY SY					
ACS-S2-8		LIBERTY STREET ENTRANCE LOBBY					
SOA-S2-1		1st FL AUX. SERV. OUTDOOR AIR SYS.					X
SOA-S2-2		2nd FL AUX. SER. OUTDOOR AIR SYS.					
SOA-S2-3		266/285 LEVELS AUX SER OUTDOOR AIR					
CRF-S2-1	3 to 7 WEST	RETURN AIR-SOUTH SECT./WEST					
CRF-S2-2	3 to 7 WEST	RETURN AIR-SOUTH SECT/WEST					
CRF-S2-3	3 to 7 WEST	RETURN AIR-SOUTH SECT/WEST					
CRF-S2-4	INT. PLAZA	RETURN AIR					
CRF-S2-5		GALLERIA RETURN FAN					
PAF-S2-1	1st FLOOR	AUXILLARY SERVICE SPILL AIR					
RVF-S2-1	INT.PLAZA.RET	285.6 MER VENTILATION					
E-S2-1	285 LEVEL	MER EXHAUST,					
VF-S2-1		SUBWAY VENTILATION					

MER STEAM PRESSURE HI ____ MED ____ LO ____

DOMESTIC HOT WATER TEMPERATURE ________

PUMP NUMBER	SERVICE	ON	OFF	SUCT. PRESS	DISCH. PRESS	TEMP. IN	TEMP. OUT	PRESSURE IN	PRESSURE OUT	COMMENTS
P-S2-1	DIR RAD + 2ND FL HTG									
P-S2-2	DIR RAD + 2nd FL HTG									
P-S2-3	AUX SER H.W.REHEAT									
P-S2-4	AUX SER H.W.REHEAT									
P-S2-5	AUX SER H.W. REHEAT									
P-S2-6	AUX SER H.W.PREHEAT									
P-S2-7	AUX SER H.W.PREHEAT									
P-S2-8	AUX SER H.W.PREHEAT									
P-S2-9	H.W. INT. REHEAT									
P-S2-10	H.W. INT. REHEAT									
P-S2-12	AUX SERV. C.W.									
P-S2-13	AUX SERV. C.W.									
P-S2-14	AUX SERV. C.W.									
Ejector #2	266 - Level									
Sump #2	337.9 Level									

TELEPHONE ________ GARBAGE PICK-UP REQUIRED: YES ____ NO: ____

M.E.R. DOOR LOCKS ________

AUXILLARY COOLING WATER SYSTEM & 294 LEVEL SEPB			PUMP PRESSURE		AUX.COOLING WATER TEMP		COOLER PRESSURES PRIMARY SIDE			SECONDARY SIDE			COMMENTS
ACW # 6	ON	OFF	SUCT	DISC	IN	OUT	IN	OUT	DIFF	IN	OUT	DIF	
P-S2-28													
P-S2-29													
P-S2-30													

OUTSIDE AIR TEMP. ____________ CHILLED WATER IN ____________

SOUTHEAST 9th FLOOR AND 2nd FLOOR MER's

FAN NUMBER	ZONE	SERVICE	ON	OFF	DISCH TEMP	SPACE TEMP.	COMMENTS
ACS-9-1		INTERIOR SUPPLY					
ACS-9-2		INTERIOR SUPPLY					
ACS-9-3		INTERIOR SUPPLY					
ACS-9-4		INTERIOR SUPPLY					
ACS-9-5		NORTH SECTION PERIPHERAL					
ACS-9-6		SOUTHEAST SECTION PERIPHERAL					
ACS-9-7		SOUTHWEST SECTION PERIPHERAL					
ACS-9-8		24hour-AUX.SERV.OUTDOOR					
ACS-9-9		NATIONAL STOCK EXCHANGE SUPPLY					
ACS-9-10		COMMODITY STOCK EXCHANGE SUPPLY					X
ACR-9-1		RETURN AIR					
ACR-9-2		RETURN AIR					
ACR-9-3		RETURN AIR					
ACR-9-4		RETURN AIR					
ACR-9-5		COMMODITY EXCHANGE RETURN AIR					
ACR-9-6		NATIONAL STOCK EXCHANGE R.A.					
FCS-9-1	310 + 2nd fl	AUX.SERV. SPILL-NORTH SECT.					
S-9-2	310 + 2nd fl	AUX.SERV. SPILL-SOUTH SECT.					
E-9-1	8th fl. North	TOILET EXHAUST					
E-9-2	310/3-8 floor	TOILET EXHAUST					
E-9-3	310 lvl&below	TOILET EXHAUST					
E-9-4	3 to 9 South	TOILET EXHAUST					
E-9-5	North Sect.	9th FLOOR MER EXHAUST					
E-9-6	South Sect.	9th FLOOR MER EXHAUST					
E-9-7	285 Level	TRUCK DOCK EXHAUST					
E-9-8	North SECT	ELEVATOR MACHINE ROOM					
E-9-9	South SECT.	ELEVATOR MACHINE ROOM					

PUMP NUMBER	SERVICE	ON	OFF	SUCT. PRESS	DISCH PRESS	TEMPERATURE IN	TEMPERATURE OUT	PRESSURE IN	PRESSURE OUT	COMMENTS
P-9-1	N + W SEC. WATER									
P-9-2	N + W SEC. WATER									
P-9-3	S + E SEC. WATER									
P-9-4	S S + E SEC WATER									
P-9-17	24 hr PREHEAT SYST									
P-9-18	24 HR PREHEAT SYST									

SEPB
2nd FLOOR MER

FAN NUMBER	ZONE	SERVICE	ON	OFF	DISC TEMP	COMMENTS
ACS-2-1	CHURCHSST.LOBBY	SUPPLY AIR				
ACS-2-2	PLAZA LOBBY	SUPPLY AIR				
ACS-2-3	2nd floor PUBLIC CON	SUPPLY AIR				

STEAM HI ____________

MED ____________

LO ____________

GARBAGE PICK-UP REQUIRED: YES ____ NO ____

TELEPHONE ____________

M.E.R. DOOR LOCKS ____________

DATE ____________

ENGINEER ____________

OUTSIDE AIR TEMP.____________ SUPPLY FAN DESIGN DISCHARGE TEMP.____________

1 WTC NORTHEAST 289.6 M.E.R.

FAN NUMBER	ZONE	SERVICE	ON	OFF	DISCH. TEMP.	COMMENTS
ACS-S2-1N		ELECTRIC SUB-STATION A/C				
ACS-S2-2N		GALLERIA SUPPLY #1				
ACS-S2-3N		GALLERIA SUPPLY #2				
ACS-S2-4N		GALLERIA SUPPLY #3				
ASOA-S2-1N	EAST	AUX.SERVICE OUTSIDE AIR				
ASOA-S2-2N	WEST	AUX. SERVICE OUTSIDE AIR				
ASOA-S2-3N	BLOCK "A"	AUX. SERVICE OUTSIDE AIR				
ASOA-S2-4N	BLOCK "B"	AUX. SERVICE OUTSIDE AIR				
ASOA-S2-5N	BLOCK C&D	AUX. SERVICE OUTSIDE AIR				
ASOA-S2-6N	BLOCK I&J	AUX. SERVICE OUTSIDE AIR				
ASOA-S2-7N		TENANT STORAGE 289.6&266				
ASOA-S2-8N		TENANT STORAGE 289.6&266				
MERS-S2-1N		M.E.R. VENTILATION 289.6				
ACR-S2-1N		ELECTRIC SUB-STATION EXH.				
ACR-S2-2N		GALLERIA RETURN SYSTEM#1				
ACR-S2-3N		GALLERIA RETURN SYSTEM#2				
ACR-S2-4N		GALLERIA RETURN SYSTEM#3				
S-S2-5N	EAST	AUX. SERVICE SPILL AIR				
S-S2-6N	WEST	AUX. SERVICE SPILL AIR				
S-S2-7N	BLOCK "A"	AUX. SERVICE SPILL AIR				
S-S2-8N	BLOCK "B"	AUX. SERVICE SPILL AIR				
S-S2-9N	BLOCK C&D	AUX. SERVICE SPILL AIR				
S-S2-10N	BLOCK I&J	AUX. SERVICE SPILL AIR				
E-S2-1N		MER EXHAUST				
E-S2-2N	BLOCK "A"	TOILET EXHAUST EL. 310				
E-S2-3N	BLOCK "B"	TOILET EXHAUST EL. 310				
E-S2-4N	BLOCK C&D	TOILET EXHAUST EL. 310				
E-S2-5N	BLOCK I&J	TOILET EXHAUST EL. 310				

TELEPHONE____________

M.E.R. DOOR LOCKS____________

PUMP NUMBER	SERVICE	ON	OFF	SUCT. PRESS.	DISCH PRESS.	TEMP. IN	TEMP. OUT	PRESSURE IN	PRESSURE OUT
P-S2-1N	AUX. SERVICE C.W.								
P-S2-2N	AUX. SERVICE C.W.								
P-S2-3N	PREHEAT HOTWATER								
P-S2-4N	PREHEAT HOTWATER								
P-S2-5N	REHEAT HOTWATER								
P-S2-6N	REHEAT HOTWATER								
P-S2-7N	REHEAT HOTWATER								
P-S2-8N	DIRECT RADIATION								
P-S2-9N	DIRECT RADIATION								

Ejector #1 & Sump #1 - 266 Level

Ejector #3 285.6 Level

Ejector #4 - 310 Level(behind Great Expectations)

HONEYWELL AIR STATION PRESSURE:____________ DOMESTIC HOTWATER TEMP.____________

M.E.R. STEAM DISCHARGE PRESS.____________

COMMENTS

GARBAGE PICK-UP REQUIRED: YES____ NO____ ENGINEER____________

DATE: / / NORTHEAST PLAZA 289.6 M.E.R.

Computer Cooling System 289.6 Level NEPB.			Pump Pressure		Aux Cooling Water Temp.		Cooler Pressures Primary Side			Secondary Side		
ACW. System 4	ON	OFF	SUCT.	DISCH	IN	OUT	IN	OUT	DIF.	IN	OUT	DIF.
ACWP-NE-1												
ACWP-NE-2												

9th FLOOR M.E.R.

OUTSIDE AIR TEMP.______________ SUPPLY FAN DESIGN DISCHARGE TEMP.______________

FAN NUMBER	ZONE	SERVICE	ON	OFF	DISCH. TEMP.	SPACE TEMP.	COMMENTS
ACS-9-1N	SOUTH&WEST	INTERIOR 5-9th FLOOR					
ACS-9-2N	SOUTH&NORTH	INTERIOR 5-8th FLOOR					
ACS-9-3N	SOUTH&NORTH	INTERIOR 5-9th FLOOR					
ACS-9-4N	NORTH&SOUTH	INTERIOR 5-8th FLOOR					
ACS-9-5N	N.- S.& E.	INTERIOR 5-8th FLOOR					
ACS-9-6N	NORTH	INTERIOR 5-8th FLOOR					
ACS-9-7N	E.- S.& W.	INTERIOR 5-9th FLOOR					
ACS-9-8N	W.-S.-N.&E.	PERIPHERAL 4-9th FLOOR					
ACS-9-9N	E.-S. & W.	PERIPHERAL 4-9th FLOOR					
ACS-9-10N	N.- W.& S.	TRADE MART DUAL DUCT 4					
ACS-9-11N	N.-E.-S.&W.	TRADE MART DUAL DUCT 4					
ACS-9-12N		LOBBY SUPPLY 2-5th FL.					
ACS-9-13N		LOBBY SUPPLY 2-5th FL.					
ACR-9-1N		RETURN 4-9th FLOOR					
ACR-9-2N		RETURN 4-9th FLOOR					Y
ACR-9-3N		RETURN 4-9th FLOOR					
ACR-9-4N		RETURN 4-9th FLOOR					
ACR-9-5N		RETURN 4-8th FLOOR					
ACR-9-6N		RETURN 4-8th FLOOR					
ACR-9-7N	WEST	LOBBY RETURN 2-5th FL.					
ACR-9-8N	EAST	LOBBY RETURN 2-5th FL.					
E-9-1N	WEST	TOILET EXHAUST					
E-9-2N	EAST	TOILET EXHAUST					
E-9-3N	WEST	M.E.R. EXHAUST					
E-9-4N	EAST	M.E.R. EXHAUST					
E-9-5N	WEST	ELEV. M.E.R. EXHAUST					
E-9-6N	EAST	ELEV. M.E.R. EXHAUST					

PUMP NUMBER	SERVICE	ON	OFF	SUCT. PRESS	DISCH. PRESS	TEMP. IN	TEMP. OUT	PRESSURE IN	PRESSURE OUT	STANDBY
P-9-1N	N.W. SECONDARY									
P-9-2N	STANDBY									
P-9-3N	S.E. SECONDARY									
P-9-4N	STANDBY									
P-9-5N	INTERIOR REHEAT									
P-9-6N	STANDBY									

HONEYWELL AIR STATION PRESSURE:______________

DOMESTIC HOTWATER TEMP.:______________ M.E.R. STEAM DISCHARGE PRESSURE:______________

TELEPHONE______________

M.E.R. DOOR LOCK______________

COMMENTS

GARBAGE PICK-UP REQUIRED: YES____ NO____ ENGINEER:______________

DATE:____/____/____ NORTHEAST PLAZA BUILDING 9th FLOOR M.E.R.

NEPB - 3rd FLOOR MERs		ZONE SERVED	SERVICE	ON	OFF	DISCH. TEMP.	Ch. WAT. IN	Ch. WAT. OUT	Reh. WAT. IN	Reh. WAT. OUT	Special Note * These 289.6 MER fans must b ASOA-S2-1N Supplys O.A. To MERs 2,3,4. ASOA-S2-2N Supplys O.A. To MER 1
MER 1	ACS-3-1NA	WEST	N.W.								
	ACS-3-1NB		N.E.								
	ACR-3-1N										
	ACR-3-2N										
MER. 2	ACS-3-2N	EAST	N.E + S.E.								
	ACR-3-3N										
MER. 3	ACS-3-3N	SOUTH	S.E.								
	ACR-3-4N										
MER. 4	ACS-3-4N	SOUTH	S.W.								
	ACR-3-5N										

A Tower

OUTSIDE AIR TEMP.____________ SUPPLY FAN DESIGN DISCH. TEM

FAN NUMBER	ZONE	SERVICE	ON	OFF	DISCH. TEMP.	COMMENTS
ACS-S5-1	SUBGRADE	BUILDING SERVICES				
ACS-S5-2	SUBGRADE	SUBSTATION AND PUMP ROOM SUPPLY				
ACS-S5-3	SUBGRADE	LOADING DOCK SUPPLY				
ACS-S5-4	SUBGRADE	SERVICE SUPPLY				
ACS-S5-5	SUBGRADE	SERVICE SUPPLY				
ACS-S5-6		PATH MEZZANINE SUPPLY				
ACS-S5-7		PATH OFFICE SUPPLY				
ACS-S5-S11		PATH TRACK SUPPLY				
VS-SL-1	SUBGRADE	GARAGE FRESH AIR MAKEUP				
VS-S5-1	SUBGRADE	TENANT STORAGE VENTILATION				
VS-S5-2	SUBGRADE	GARAGE FRESH AIR MAKEUP				
VS-S5-3	SUBGRADE	M.E.R. VENTILATION				
VS-S5-4	SUBGRADE	TENANT STORAGE VENTILATION				
VS-S5-5	SUBGRADE	TENANT STORAGE VENTILATION				
VS-S5-6	SUBGRADE	TRUCK DOCK VENTILATION				
VS-S5-7	SUBGRADE	M.E.R. VENTILATION				
VS-S5-8	SUBGRADE	TRUCK DOCK VENTILATION				
VS-S5-9A	SUBGRADE	REFRIGERATION ROOM VENTILATION				
VS-S5-9B	SUBGRADE	REFRIGERATION ROOM VENTILATION				
VS-S5-9C	SUBGRADE	REFRIGERATION ROOM VENTILATION				
VS-S5-10	SUBGRADE	TENANT STORAGE VENTILATION				
VS-S5-11	SUBGRADE	GENERATOR ROOM VENTILATION				
ACR-S5-1	SUBGRADE	BUILDING SERVICES RETURN AIR FAN				
ACR-S5-2	SUBGRADE	SUBSTATION AND PUMP ROOM RETURN				
ACR-S5-3	SUBGRADE	LOADING DOCK RETURN AIR FAN				
ACR-S5-5	SUBGRADE	SERVICE RETURN				
ACR-S5-6		PATH MEZZANINE RETURN AIR FAN				
ACR-S5-7		PATH OFFICE RETURN AIR FAN				
E-S5-7	SUBGRADE	M.E.R. EXHAUST FAN				
E-S5-8	SUBGRADE	M.E.R. EXHAUST FAN				
T-S3-1		TRANSFERE FAN 264 LEVEL				
T-S2-1		TRANSFERE FAN 274 LEVEL				
T-S2-2		TRANSFERE FAN 274 LEVEL				
TS1-1		TRANSFERE FAN 284 LEVEL				

CONDENSATE PUMPS

PUMP NUMBER	LE.	LAG.	COMMENTS
CP-S5-2A			
CP-S5-2B			
CP-S5-1A			
CP-S5-1B			

HONEYWELL AIR STATION PRESSURE:__________ TELEPHONE______________

M.E.R. STEAM DISCHARGE PRESSURE:__________ M.E.R. DOOR LOCKS______________

ENGINEER:________________

DATE:___/___/___ M.E.R. #5 TOWER "A" 242 LEVEL WATCH:________________

GARBAGE PICK-UP REQUIRED: YES____ NO____

OUTSIDE AIR TEMP.____________ SUPPLY FAN DESIGN DISCHARGE TEMP.____________

7th FLOOR M.E.R. TOWER "A"

FAN NUMBER	ZONE	SERVICE	ON	OFF	SPACE SENSOR READING °F 9:00 AM	11:30 AM	2:30PM
ACS-7-1	NORTH	PERIPHERAL 9-24th FLOOR					
ACS-7-2	EAST	PERIPHERAL 9-24th FLOOR					
ACS-7-3	SOUTH	PERIPHERAL 9-24th FLOOR					
ACS-7-4	WEST	PERIPHERAL 9-24th FLOOR					
ACS-7-5	NORTHWEST	INTERIOR 9-24th FLOOR					
ACS-7-6	NORTHEAST	INTERIOR 9-24th FLOOR					
ACS-7-7	SOUTHEAST	INTERIOR 9-24th FLOOR					
ACS-7-8	SOUTHWEST	INTERIOR 9-24th FLOOR					
ACS-7-9	NORTHWEST	CORE 2-6th FLOOR					
ACS-7-10	EAST&WEST	CORE 9-24th FLOOR					
ACS-7-11	NORTHWEST	LOBBY SUPPLY					
ACS-7-12	SOUTHEAST	LOBBY SUPPLY					
ACS-7-13		PLAZA SUPPLY					
ACS-7-14		CONCOURSE SUPPLY					
ACR-7-1	NORTHWEST	RETURN 9-24th FLOOR					
ACR-7-2	NORTHWEST	RETURN 9-24th FLOOR					
ACR-7-3	NORTHEAST	RETURN 9-24th FLOOR					
ACR-7-4	NORTHEAST	RETURN 9-24th FLOOR					
ACR-7-5	SOUTHEAST	RETURN 9-24th FLOOR					
ACR-7-6	SOUTHEAST	RETURN 9-24th FLOOR					
ACR 7-7	SOUTHWEST	RETURN 9-24th FLOOR					
ACR-7-8	SOUTHWEST	RETURN 9-24th FLOOR					
ACR-7-9	NORTHWEST	CORE RETURN 2-6th FLOOR					
ACR-7-10	NORTHWEST	LOBBY RETURN					
ACR-7-11	SOUTHEAST	LOBBY RETURN					
ACR-7-12		PLAZA RETURN					
ACR-7-13		CONCOURSE RETURN					
E-7-14	WEST	TOILET EXHAUST					
E-7-15		TOILET EXHAUST					
E-7-16		TOILET EXH. BELOW 1st FL.					
E-7-17		LOCAL ELEV. M.R. EXHAUST					
E-7-18		M.E.R. EXHAUST					
E-7-19		M.E.R. EXHAUST					
E-7-20		ELECT. SUB-STATION EXHAUST					
E-7-21		ELECT. SUB-STATION EXHAUST					

SECURITY SYSTEMS CHECKLIS

MER DOORS F.E. SECURIT

Stair A____ 5 Car____

" B____ 50 " ____

" C____ 48 "

SETBACK NW____

" SE____

CODE

✓ All OK

X NG (See Remarks)

GARBAGE PICK-UP REQUIRED:

TELEPHONE____________

REMARKS (~~List Deficiencie~~

@ 9:00 A.M.

PUMP NUMBER	SERVICE	ON	OFF	SUCTION PRESS	DISCH. PRESS.	TEMP. IN	TEMP. OUT	PRESSURE IN	PRESSURE OUT	CO
P-7-1	N.W.Sec. 9-24									
P-7-2	STANDBY									
P-7-3	S.E.Sec. 9-24									
P-7-4	STANDBY									
P-7-5	INTERIOR REHEAT									
P-7-6	STANDBY 9-24									

HONEYWELL AIR STATION PRESSURES: N.W._____ N.E._____ S.W._____ S.E._____

DOMESTIC HOTWATER TEMP.__________ M.E.R. STEAM DISCHARGE PRESS.__________

COMMENTS

ENGINEER____________

DATE___/___/___ TOWER "A" 7th FLOOR M.E.R. WATCH:__________

OUTSIDE AIR TEMP.________ SUPPLY FAN DISCHARGE TEMP. DESIGN________

41st FLOOR M.E.R. TOWER "A"

FAN NUMBER	ZONE	SERVICE	ON	OFF	SPACE SENSOR READINGS ° F 9:00 AM U	D	11:30 A.M. U	D	2:30 P.M. U	D	4:3 U
ACS-41-1	NORTH	PERIPHERAL 25-58th FLOOR									
ACS-41-2	EAST	PERIPHERAL 25-58th FLOOR									
ACS-41-3	SOUTH	PERIPHERAL 25-58th FLOOR									
ACS-41-4	WEST	PERIPHERAL 25-58th FLOOR									
ACS-41-5	NORTHWEST	INTERIOR AIR 25-40th FLOOR									
ACS-41-6	NORTHEAST	INTERIOR AIR 25-40th FLOOR									
ACS-41-7	SOUTHEAST	INTERIOR AIR 25-40th FLOOR									
ACS-41-8	SOUTHWEST	INTERIOR AIR 25-40th FLOOR									
ACS-41-9	NORTHWEST	INTERIOR AIR 44-58th FLOOR									
ACS-41-10	NORTHEAST	INTERIOR AIR 44-58th FLOOR									
ACS-41-11	SOUTHEAST	INTERIOR AIR 44-58th FLOOR									
ACS-41-12	SOUTHWEST	INTERIOR AIR 44-58th FLOOR									
ACS-41-13	WEST	CORE 25-58th FLOOR									
ACS-41-14	EAST	CORE 25-58th FLOOR									
ACS-41-15	WEST	SHUTTLE ELEV. M.R. 47th FL.									
ACS-41-16	EAST	SHUTTLE ELEV. M.R. 41-47									
ACR-41-1	NORTHWEST	RETURN 25-58th FLOOR									
ACR-41-2	NORTHWEST	RETURN 25-58th FLOOR									
ACR-41-3	NORTHWEST	RETURN 25-58th FLOOR									
ACR-41-4	NORTHEAST	RETURN 25-58th FLOOR									
ACR-41-5	NORTHEAST	RETURN 25-58th FLOOR									
ACR-41-6	NORTHEAST	RETURN 25-58th FLOOR									
ACR-41-7	SOUTHEAST	RETURN 25-58th FLOOR									
ACR-41-8	SOUTHEAST	RETURN 25-58th FLOOR									
ACR-41-9	SOUTHEAST	RETURN 25-58th FLOOR									
ACR-41-10	SOUTHWEST	RETURN 25-58th FLOOR									
ACR-41-11	SOUTHWEST	RETURN 25-58th FLOOR									
ACR-41-12	SOUTHWEST	RETURN 25-58th FLOOR									
E-41-13	WEST	TOILET EXHAUST 25-58th FL.									
E-41-14	EAST	TOILET EXHAUST 25-58th FL.									
E-41-15	WEST	ELEV. M.R. EXHAUST 32nd									
E-41-16	EAST	ELEV. M.R. EXHAUST 25th									
E-41-17	EAST	ELEV. M.R. EXHAUST 47th									
E-41-18	WEST	M.E.R. EXHAUST									
E-41-19	EAST	M.E.R. EXHAUST									
E-41-20	NORTH	ELECT. SUB-STATION EXHAUST									
E-41-21	SOUTH	ELECT. SUB-STATION EXHAUST									

SECURITY SYSTEMS CHECKLIST

MER DOORS — Stair A____ " B____ " C____

F.E. SECURITY CAGE — 17 Car____ 50 "____

SETBACK NW____ SE____

CODE
✓ ALL OK
X NG (See Remarks)

GARBAGE PICK-UP REQUIRED: YES_NO

TELEPHONE________

REMARKS: LIST DEFICIENCIES

TELEPHONE________ M.E.R. DOOR LOCKS________

@ 9:00 A.M.

PUMP NUMBER	SERVICE	ON	OFF	PUMPS SUCTION PRESS.	DISCH. PRESS.	HEAT EXCHANGERS TEMP. IN	OUT	PRESSURE IN	OUT	COMMENTS
P-41-1	N.W. Sec. 25-40									
P-41-2	STANDBY									
P-41-3	S.E. Sec. 25-40									
P-41-4	STANDBY									
P-41-5	N.W. Sec. 43-58									
P-41-6	STANDBY									
P-41-7	S.E. Sec. 43-58									
P-41-8	STANDBY									
P-41-9	INTERIOR REHEAT									
P-41-10	STANDBY 25-40									
P-41-11	INTERIOR REHEAT									
P-41-12	STANDBY 43-58									

HONEYWELL AIR STATION - N.W.____ N.E.____ S.W.____ S.E.____
PRESSURES:

DOMESTIC HOTWATER TEMP. - UPFEED______ DOWNFEED______ M.E.R. STEAM DISCHARGE PRESS.____

Computer Cooling 43rd Floor Tower A			Pump Pressure		Aux. Cooling Wtr. Temp.		Cooler Pressures Primary Side			Secondary Side		
ACW System 2	ON	OFF	SUCT	DIF.	IN	OUT	IN	OUT	DIF.	IN	OUT	DIF.
ACWP-43-1												
ACWP 43-2												

ENGINEER________

DATE___/___/___ TOWER "A" 41st FLOOR M.E.R. WATCH:________

OUTSIDE AIR TEMP.__________ SUPPLY FAN DESIGN DISCHARGE TEMP.________

75th FLOOR M.E.R. TOWER "A"

FAN NUMBER	ZONE	SERVICE	ON	OFF	DISCH. TEMP.	SPACE TEMP.	COMMENTS
ACS-75-1	NORTH	PERIPHERAL AIR 59-91st FL.				UP: DOWN:	
ACS-75-2	EAST	PERIPHERAL AIR 59-91st FL.				UP: DOWN:	
ACS-75-3	SOUTH	PERIPHERAL AIR 59-91st FL.				UP: DOWN:	
ACS-75-4	WEST	PERIPHERAL AIR 59-91st FL.				UP: DOWN:	
ACS-75-5	NORTHWEST	INTERIOR AIR 59-74th FLOOR					
ACS-75-6	NORTHEAST	INTERIOR AIR 59-74th FLOOR					
ACS-75-7	SOUTHEAST	INTERIOR AIR 59-74th FLOOR					
ACS-75-8	SOUTHWEST	INTERIOR AIR 59-74th FLOOR					
ACS-75-9	NORTHWEST	INTERIOR AIR 77-91st FLOOR					
ACS-75-10	NORTHEAST	INTERIOR AIR 77-91st FLOOR					
ACS-75-11	SOUTHEAST	INTERIOR AIR 77-91st FLOOR					
ACS-75-12	SOUTHWEST	INTERIOR AIR 77-91st FLOOR					
ACS-75-13	WEST	CORE 59-91st FLOOR					
ACS-75-14	EAST	CORE 59-91st FLOOR					
ACS-75-15	WEST	SHUTTLE ELEV M.R. 81st FL.					X
ACS-75-16	EAST	SHUTTLE ELEV.M.R. 75-76-81					
ACR-75-1	NORTHWEST	RETURN AIR 59-91st FLOOR					
ACR-75-2	NORTHWEST	RETURN AIR 59-91st FLOOR					
ACR-75-3	NORTHWEST	RETURN AIR 59-91st FLOOR					
ACR-75-4	NORTHEAST	RETURN AIR 59-91st FLOOR					
ACR-75-5	NORTHEAST	RETURN AIR 59-91st FLOOR					
ACR-75-6	NORTHEAST	RETURN AIR 59-91st FLOOR					
ACR-75-7	SOUTHEAST	RETURN AIR 59-91st FLOOR					
ACR-75-8	SOUTHEAST	RETURN AIR 59-91st FLOOR					
ACR-75-9	SOUTHEAST	RETURN AIR 59-91st FLOOR					
ACR-75-10	SOUTHWEST	RETURN AIR 59-91st FLOOR					
ACR-75-11	SOUTHWEST	RETURN AIR 59-91st FLOOR					
ACR-75-12	SOUTHWEST	RETURN AIR 59-91st FLOOR					
E-75-13	WEST	TOILET EXHAUST 59-91st FL.					
E-75-14	EAST	TOILET EXHAUST 59-91st FL.					
E-75-15	WEST	LOCAL ELEV. M.R. EXHAUST					
E-75-16	EAST	LOCAL ELEV. M.R. EXHAUST					
E-75-17	WEST	SHUTTLE ELEV. M.R. EXH. 81					
E-75-18	EAST	SHUTTLE ELEV M.R. EXH. 75&81					
E-75-19	WEST	M.E.R. EXHAUST					
E-75-20	EAST	M.E.R. EXHAUST					
E-75-21	NORTH	ELECT. SUB-STATION EXHAUST					
E-75-22	SOUTH	ELECT. SUB-STATION EXHAUST					

SECURITY SYSTEMS CHECKLIST

MER DOORS
Stair A ___
" B ___
" C ___

F.E. SECURITY CAG
6 Car ______
50" ______

SETBACK NW ___
SE ___

CODE
✓All O.K.
X NG See Rem

GARBAGE PICK-UP REQUIRED: YES__N
TELEPHONE______

REMARKS: LIST DEFICIENCIES

PUMP NUMBER	SERVICE	ON	OFF	SUCTION PRESS.	DISCH. PRESS.	TEMP. IN	TEMP. OUT	PRESSURE IN	PRESSURE OUT	COMMENTS
P-75-1	SEC. N.W. 59-74									
P-75-2	STANDBY									
P-75-3	SEC. S.E. 59-74									
P-75-4	STANDBY									
P-75-5	SEC. N.W. 77-91									
P-75-6	STANDBY									
P-75-7	SEC. S.E. 77-91									
P-75-8	STANDBY									
P-75-9	INTERIOR REHEAT									
P-75-10	STANDBY 59-74									
P-75-11	INTERIOR REHEAT									
P-75-12	STANDBY 77-91									

HONEYWELL AIR STATION PRESSURES: N.W._____ N.E._____ S.W._____ S.E._____

DOMESTIC HOTWATER TEMP. UPFEED_____ DOWNFEED______ M.E.R. STEAM DISCHARGE PRESS.__________

COMMENTS

ENGINEER______________

DATE__/__/____ TOWER"A" 75th FLOOR M.E.R. WATCH:________

WORLD TRADE CENTER

Manual No. 15

Operation and Maintenance of

HVAC SYSTEM
TOWERS A&B

Final Edition
Engineering Department
Publication, June 1987

THE PORT AUTHORITY OF NY & NJ

F O R E W O R D

The information in this manual is presented as an aid to all personnel who operate and maintain the Heating, Ventilating, and Air Conditioning System in Towers A and B of the World Trade Center.

This manual should be used with, and must comply with, all Port Authority safety practices and precautions presently in effect at the World Trade Center.

The contents of this manual have been researched, compiled, and prepared by the Maintenance Methods Section of the Maintenance Engineering Design Division, Engineering Department, with the cooperation of the World Trade Department.

P R E F A C E

The text and diagrams presented in this manual reflect the status of the Heating, Ventilating, and Air Conditioning equipment and controls as they were originally installed in Towers A and B in 1970 under WTC Contracts Nos. 502 and 511.

C O N T E N T S

CONTENTS

CONTENTS

CHAPTER 1

INTRODUCTION

SCOPE

The Heating, Ventilating, and Air Conditioning (HVAC) System in Towers A and B of the World Trade Center (WTC) is the subject of this manual. The system is described as it was at the time of original installation.

Chapter 1 is the Introduction to the manual. The chapter contains descriptions of the general layouts of Towers A and B and the locations of the Mechanical Equipment Rooms in the towers. Also in the chapter is general information regarding: the types of air conditioning systems in the towers, the chilled water that cools the towers, and the steam that is the primary source of heat for the Trade Center.

Chapter 2 describes the steam supply to the towers and its distribution to the HVAC System.

Chapter 3 focuses on the Chilled Water Distribution System in the towers and the locations of the quick-fill and drain valves.

Chapter 4 describes the various categories of HVAC Systems and units in the towers and includes information regarding their return air and exhaust fans. The chapter also contains information regarding the Central Control System in the Trade Center.

Chapter 5 deals with the system that supplies heated water to the reheat coils in the supply ducts of the Interior Air Conditioning System.

Chapter 6 covers the Secondary Water System that provides hot and cold water for the Peripheral Air Conditioning Systems in the towers.

Chapter 7 deals with the methods by which air from the various categories of HVAC units is discharged on each floor of the towers. The chapter also describes how air is returned to the HVAC units or exhausted from the towers.

GENERAL

The HVAC design for the towers of the World Trade Center, for the most part, is traditional. After chilled water from a Central Refrigeration Plant and steam, purchased from Con Edison, are piped to a Mechanical Equipment Room (MER), both are distributed to the HVAC equipment in the same manner as in most large buildings requiring an MER of similar capacity. This system is repeated 4 times in each tower, as each tower can be considered to be 4 buildings in one, each building one above the other, and each having one MER. See Figure 1.1.

CHILLED WATER PLANT AND DISTRIBUTION SYSTEM

A Central Refrigeration Plant, located on Levels B4, B5, and B6, approximately midway between Towers A and B, produces chilled water. This chilled water is used to cool all the buildings in the

Trade Center. An intricate piping system carries the chilled water from the refrigeration plant to all MERs in Towers A & B, the Northeast Plaza Building, the Southeast Plaza Building, the Customhouse, and the Hotel.

The refrigeration plant comprises seven, 7,000-ton, centrifugal refrigeration machines. They reduce the temperature of the chilled water from 54 degrees F to 38 degrees F. A comprehensive discription of the operation of the Central Refrigeration Plant is in WTC O&M Manual No. 3 "Mechanical Systems, Central Refrigeration Plant".

STEAM SERVICE AND DISTRIBUTION SYSTEM

The primary source of heat in the Trade Center is steam purchased from Con Edison and supplied at 125 PSI to a meter room on Level B5. From the meter room the steam is piped at high pressure to MERs throughout the Trade Center. A detailed description of the Steam Meter Room is in WTC O&M Manual No. 17, "HVAC System, Subgrade Levels".

In the MERs the steam is passed through a pressure-reducing station, where the pressure is reduced to 15 PSI. The steam is then distributed to: preheat and reheat coils in Peripheral, Core, and shuttle Elevator Machine Room (EMR) HVAC Units; preheat coils in Interior HVAC units; and steam-to-hot water converters in the Secondary Water System and Interior Reheat System. Descriptions of these systems follow in this chapter.

General

For air conditioning purposes, the space on every office floor in the towers is divided into 3 areas: Peripheral, Interior, and Core. See Figure 1.2.

Core Air

The Core area on each floor comprises: an elevator lobby or lobbies; the public corridors that extend to the north, east, south, and west regions of the floor; and the ladies' and men's toilets. Conditioned air is distributed to the east and west sides of the Core areas on each floor and the bank EMRs on some floors via vertical riser ducts that emanate from the Core HVAC units in the MERs. From the vertical risers the conditioned air is ducted to fluorescent light fixture/air diffusers in the ceilings of the Core area and diffusers in the bank EMRs.

Air from the Core areas is not returned to the MERs. It is vented through louvers in the doors of the men's and ladies' toilets and exhausted from the building via toilet exhaust fans. In addition, air from all the EMRs is exhausted from the building via exhaust fans.

Interior Air

The balance of the floor is divided into 2 areas; Interior and Peripheral. See Figure 1.2. The Interior area begins at the north, east, south, and west perimeter of the Core area and extends north, east, south, and west to within 15 feet of the 4

perimeter walls. These 15 feet to the perimeter walls (windows) are known as the Peripheral area. See Figure 1.2.

For air conditioning purposes, the Interior area is further subdivided into 4 quadrants: Northwest, Northeast, Southeast, and Southwest. See Figure 1.2. Conditioned air from the Interior HVAC units in the MERs is carried to each tenanted floor by vertical riser ducts in the towers. Then, on each floor, 4 large ducts (one for each quadrant) carry the conditioned air from the vertical risers to designated combination light fixture/air diffusers in the ceilings of the Interior areas.

Return air from the Interior area on each floor is drawn through open fluorescent light troffers into a ceiling plenum by return air fans in the MERs. The return air passes from the plenum back to the center (Core) of the building. In the Core the return air is pulled up or down through air shafts by the return air fans to return air plenums in the MERs.

From the return air plenums, the air is ducted to spill air plenums on the north and south sides of the MERs. Then, supply fans in the Interior HVAC units draw the return air into the HVAC units.

Peripheral Air

The Peripheral areas on each floor are cooled and heated by the Peripheral/air conditioning system. There are 4 Peripheral areas on each floor. They are designated by the compass points: north, east, south, and west. See Figure 1.2.

The air conditioning of these areas is accomplished by Induction air conditioning units. These Induction units combine primary air, which is supplied by the Peripheral HVAC units in the MERs, with local room air that is induced to flow through coils in the Induction units. The induced air is further conditioned locally by cooled or heated secondary water that flows through the coils in the Induction units. A comprehensive description of the Secondary Water System and the Induction units is in Chapter 6 of this manual.

The primary air to each of the 4 areas on a floor is supplied by a separate HVAC unit. The air is ducted to the Induction units from the MERs via vertical riser ducts in the towers' core shafts and horizontal runs in the hung ceilings directly below the Induction units. The Induction units are installed along the bottoms of the window walls around the periphery of each floor.

Elevator Machine Room
HVAC Systems

In addition to the Peripheral, Core, and Interior HVAC units there are HVAC units that air condition the freight and shuttle elevator machine rooms (EMRs). These HVAC units are also in the MERs. Ductwork from each HVAC unit carries the air to the Interiors of the towers where vertical riser ducts convey the conditioned air to the EMRs. As in the Core systems, air from the EMRs does not return to the HVAC units; it is exhausted from the towers by exhaust fans.

Main Lobby HVAC Systems

The main lobby of each tower is air conditioned by 4 separate HVAC units. These units are in the 7th floor MER. Descriptions of the operation of these units are in Chapter 4 of this manual.

CENTRAL CONTROL

General

The HVAC system and its support systems are controlled from a Central Control on Level B4, overlooking the Central Refrigeration Plant. The control center is a Honeywell System 20, incorporating a computer with a 16,384-word, 960-nanosecond core memory and a 196,000-word, fixed-disk bulk memory. Although the system does not presently provide for continuous computer adjustment of local control systems to produce the best obtainable set of operating conditions, this feature can be incorporated at a later date.

Operation

Over 6,500 remote sensors detect key building parameters. Signals from these sensors (analogs of temperatures, pressures, and humidities) are transmitted to the central control console (computer) via multiplex trunk cables to complete circuits at remote points in a predetermined sequence. As circuits become energized, relays close to activate the sensors.

All remote points are continuously monitored in a matter of seconds. When a remote sensor in alarm condition is reached by

the scanner, a high-speed alarm typewriter prints the identification of the off-normal point, and audible and visible alarms are issued at the central console.

The computer compares the remote data with data describing normal conditions in the machine's memory to determine if malfunctions do indeed exist, and where. The computer also does much more. A 30-channel programmer turns equipment on and off according to a schedule.

The programmer can shut down entire systems over weekends and restart them Monday morning. It accounts for holidays, leap years, and months with different numbers of days, selecting loads for each condition accordingly.

By comparing ideal performance with actual performance, the computer can spot efficiency falloffs before they become emergencies. The computer can indicate areas in the refrigeration plant, the chilled water distribution system, the air handling systems, and other building systems where improvement could achieve operating economies.

Twin TV screens display color-coded schematics of the HVAC System. In an emergency, these screens automatically show the operator where a malfunction exists. Under normal conditions the screens can also display key system schematics at the touch of a button. Pushbuttons can then be actuated to control the equipment shown on the schematic.

In the towers, outdoor sensors monitor wet- and dry-bulb temperatures at each aboveground MER. Wind direction and speed are sensed at a station atop Tower A. Since there may be fog at ground level but sun at the top, temperature readings at different locations along the tower walls are necessary.

NOTES ON TEXT, DIAGRAMS, AND PHOTOS

1. The text, diagrams, and photos in this manual reflect the status of the equipment as it was installed under the original contracts in 1970.
2. All electric, electronic, and electropneumatic devices appearing in the diagrams of this manual are shown in their deenergized or shelf state, unless otherwise stated.

NOTES ON APPENDICES

Appendices A, B, C, and D are at the back of this manual.

Appendix A contains all the diagrams and photos required to support the text in each chapter. The illustrations are numbered and presented in the order in which they are first referred to.

Appendix B is an alphabetical listing, with definitions, of the abbreviations or designations in the text and illustrations of the manual.

Appendix C is a listing, with definitions, of the symbols in the diagrams.

Appendix D is a list of references used in the preparation of this manual. The references consist of Port Authority specifications and contract drawings, and Honeywell shop drawings. They should be referred to to gain additional information regarding specific components in the HVAC System.

CHAPTER 2

STEAM SYSTEM

SCOPE

The steam supply system in Towers A and B is dealt with in this chapter. Included in the chapter are descriptions of the expansion joints in the risers, the Pressure Reducing Stations, and the flash tanks.

GENERAL

All steam for the Trade Center is purchased from Con Edison. High Pressure Steam (HPS) is delivered to the Trade Center via a distribution main that runs under Greenwich Street. From the main, the steam is piped into the steam meter room on Elevation 242'. The arrangement and description of the metering equipment in the meter room are in WTC O&M Manual No. 17, "HVAC System, Subgrade Levels".

From the steam meter room, the HPS at 125 PSIG is piped in 12-inch risers up the towers to Pressure Reducing Stations in the MERs. There is one Pressure Reducing Station in each MER. In these Pressure Reducing Stations the HPS is reduced to low pressure steam (LPS). From the Pressure Reducing Station, the LPS is piped to all heating coils and humidifiers in the air conditioning supply units in the MER, and to the converters for the Interior

Reheat and Secondary Water Systems. Descriptions of the operation of these components are in the chapters that follow.

Steam condensate from all heating coils and converters in the MER is collected via drains and pipes under the floors of the MERs and carried via the low pressure return (LPR) risers to the next lower MER. In the lower MER, the condensate is utilized by the domestic hot water preheaters, collected again, and piped to the main condensate collection tank on Elevation 242'.

From the collection tank, the condensate is pumped to the Southeast Plaza Building, where it is used for interior reheat water and makeup water for the Plaza Sculpture Fountain. A comprehensive description of the entire World Trade Center condensate system is in the WTC operations manual, "Miscellaneous Systems".

EXPANSION JOINTS

Included in the HPS risers in each tower are 8 expansion joints. Two joints are accessible in each MER. The joints are ADSCO, type P, piston-ring units with welding ends and no bases. The sizes of the joints in the system vary, but 2 typical joints can be seen in Figure 2.1. A sectional view of the interior of the joint and its features is in Figure 2.2.

One advantage of this type of joint over others is that its packing can be replaced without removing steam pressure. This is made possible by the fact that the piston rings (see Figure 2.2) hold back the pressure while packing is added or replaced.

The vent valve discharges the small amount of fluid that may bypass the piston rings. This leaves the vent chamber at atmospheric pressure, thereby relieving the stuffing box area of all pressure.

The difference between full pressure on the line side of the piston rings and atmospheric pressure on the stuffing box side seals the rings against the body. The gland can then be pulled back, the old packing replaced with new, and the gland tightened again.

PRESSURE REDUCING STATIONS

General

The HPS risers branch off in each MER (7th, 41st, 75th, and 108th floors) to supply the steam required by the HVAC equipment in the MER. At the point where the risers enter an MER, in the northwest return air plenum, there are 2 main shutoff valves. The shutoff valves in the 41st floor MER can be seen in Figure 2.3. The valves in the other MERs are similar, but the heights at which they are located in each MER, and their accessibilities, differ.

From the point at which the HPS enters an MER, it is piped to the Pressure Reducing Station, where it is reduced from 125 PSIG to LPS (15 PSIG). There is 1 Pressure Reducing Station in each MER. The station supplies LPS to all base building HVAC units in that MER, and to the heat exchangers for the Interior Reheat and Secondary Water Systems.

All Pressure Reducing Stations in the towers are similar and operate in a similar manner. Though there may be differences in pipe and valve sizes and capacities among the Pressure Reducing Stations in Towers A and B, for purposes of explanation in this manual the station in the 75th floor MER, Tower A, will be considered typical for all stations in both towers. See Figure 2.4.

The Pressure Reducing Station comprises 2 demand circuits of pressure reducing valves (PRVs): a high demand and a low demand. See Figures 2.4 and 2.5. The high-demand circuit is sized to handle 100% of the maxium station load (51,000 lbs./hr.) and the low-demand circuit is sized to handle 20 to 30% of the maximum station load (13,500 lbs./hr.).

Operation of the Prssure Reducing Station is such that under low-load conditions, the low-demand circuit is in control. The PRVs in the station are normally closed. Upon an increase in demand for steam, the PRVs in the low-demand circuit gradually open further and further to meet the increased demand. However, when the demand rises above 13,500 lbs./hr., the low-demand circuit shuts down and the high-demand circuit takes over. A detailed description of the operation of the Pressure Reducing Station is in the paragraphs that follow.

Both demand circuits in the station comprise 2 shutoff valves, 2 PRVs, gages, and associated steam-trap piping. See Figures 2.4 and 2.5. Controlling the operation of the Pressure Reducing

Station is a group of Control Pilots (CPs). The CPs are on a yellow board that is adjacent to the low pressure side of the station. See Figure 2.6.

Pressure Reducing Valves

The PRVs in the Pressure Reducing Stations are Leslie, diaphragm-operated, class DBY control valves of various sizes. See Figures 2.4 and 2.7. Control air exerting a downward pressure on the diaphragm of the valve causes it to open and allow steam to pass through to its downstream side. Note that most of the PRVs are equipped with handwheels. The function of the handwheels is to provide a backup to the automatic operation of the valves. If control air is lost, the valves can be opened and closed manually via the handwheels.

Control Pilots

The control pilots (CPs) are Leslie, type PRA, constant pressure, reverse-acting, pneumatic relays. See Figures 2.6 and 2.8. A decrease in the controlled steam pressure to the control pilot causes a stem in the pilot to move downward, thereby opening a valve in the pilot and increasing control air pressure to the diaphragm of the PRV it controls, or a port in the transfer valve. The continued operation of the control pilots in the control circuit is described in the "Operation" section that follows in this chapter.

At this point, it is important to note that the control pilots are designated "PRV" on the board on which they are mounted. See

Figure 2.6. However, in this manual the designation "PRV" refers to the pressure reducing valves only. The control pilots are designated "CP".

Transfer Valve

The transfer valve (see Figures 2.6 and 2.8) is a pneumatic switch whose function is to select the demand circuit (high or low) that will control the flow of steam. The minimum adjustment of the piston spring in the transfer valve produces control air flow between ports A and B of the valve. See Figure 2.8. A reference signal from port B is fed to port F. This action places the low-demand circuit in control. The continued operation of the transfer valve within the control circuit is described in the following paragraphs.

Operation

Pressure reducing valves PRV 75-1 and 75-3 are primary valves whose function is to reduce the HPS (125 PSIG) to medium pressure steam (50 PSIG). See Figures 2.6 and 2.8. Pressure reducing valves PRV 75-2 and 75-4 are secondary valves. They reduce the medium pressure steam (MPS) to LPS (15 PSIG), and acting in conjunction with the transfer valves, select the demand circuit that will carry the entire steam load.

When the demand for steam in the MER is below 13,500 lbs./hr., the low-demand circuit, consisting of PRV 75-3 and 75-4, is in control. See Figure 2.8. As the demand for steam increases, the pressure of the LPS supply falls. This decrease in pressure is

sensed by control pilot CP 75-4. The decreased pressure causes a stem in the control pilot to move downward, thereby increasing control air pressure to automatic control valve PRV 75-4, via ports A and B of the transfer valve. The increased air pressure on the diaphragm of PRV 75-4 causes the valve to open further and allow more steam to pass through to supply the increased demand. This causes the pressure of the MPS to fall. The decrease in MPS pressure is sensed by control pilot CP 75-3, which then increases control air pressure to the diaphragm of control valve PRV 75-3. This causes PRV 75-3 to open further and allow more HPS to pass through to satisfy the increased demand.

As the demand for steam increases to the point at which the low-demand circuit cannot handle the load any longer (greater than 13,500 lbs./hr.), the LPS pressure drops below 12 PSIG. At this point, control pilot CP 75-2 takes over and its output air pressure, which is supplied to ports C and E of the transfer valve, rises. The air pressure to port E acts on a piston in the transfer valve and produces an upward force on the piston, which must exceed the downward force exerted by a spring in the valve and the reference signal to port F.

When this occurs: port A in the transfer valve is sealed; port B is vented; low-demand control valve PRV 75-4 closes; and the control air flows between ports C and D of the transfer valve to the diaphragm of high-demand valve PRV 75-2, causing it to open. This causes the MPS pressure in the high-demand circuit to drop. This decrease in pressure is sensed by control pilot CP 75-1,

which then opens control valve PRV 75-1. In this manner, the high-demand circuit takes over control of the steam load.

Upon a decrease in steam demand, the control circuit operates in reverse manner, and when the demand drops below 13,500 lbs./hr., control is transferred back to the low-demand circuit.

Safety Control Pilot

The safety control pilot is a pressure limiting device. It is a Leslie, type PRQ pilot, which is similar in construction and function to the type PRA control pilots, but the safety control pilot is faster acting. It automatically takes control of the system and closes high-demand control valve PRV 75-1 if the pressure of the LPS exceeds 15 PSIG.

Station Alarms

Associated with the Pressure Reducing Station is the Honeywell Central Control System. This system monitors the Pressure Reducing Station by means of pressure switches. These switches, mounted on the station, are Mercoid, electro-mechanical devices that are designated PS1 thru PS5. See Figure 2.5. Their function is to monitor the MPS and LPS, and transmit an electrical signal to the Central Control System if and when the MPS and LPS pressures exceed preset highs or drop below preset lows. PS1, PS3, and PS5 are high-pressure alarms. PS2 and PS4 are low-pressure alarms.

FLASH TANK

A flash tank is an integral part of the steam system in each MER. The tank is hung from the ceiling beams in the MER, about 10 feet above the MER floor. See Figure 2.9. The tank's function is to "flash" the high pressure and medium pressure condensate, that passes through the steam traps of the PRV station and the HPS feeder, into LPS and condensate. The LPS from the flash tank is piped into the LPS feeder in the MER, and the condensate is piped into the condensate return system. See Figures 2.5 and 2.10.

CHAPTER 3

CHILLED WATER DISTRIBUTION SYSTEM

SCOPE

The Chilled Water Distribution System for both towers is covered in this chapter. It includes discussions concerning the differential pressure bypass in each MER, the associated chilled water bypass valves, and their controls. The chapter also describes the quick-fill and drain valves and the expansion tanks.

GENERAL

The chilled water required by the cooling coils in the HVAC units and the secondary water coolers in the MERs is piped to the MERs via 2 chilled water riser systems. One system supplies the "low zone" of the towers, which includes the 7th and 41st floor MERs; the other system supplies the "high zone" of the towers, comprising the 75th and 108th floor MERs. A description of the entire Chilled Water Distribution System in the World Trade Center is in WTC O&M Manual "Miscellaneous Electrical and Mechanical Systems".

DIFFERENTIAL PRESSURE BYPASS

General

At the points where the MERs are tapped off the chilled water supply (CHWS) and chilled water return (CHWR) risers, there is a differential pressure bypass. Controlling the flow of water through this bypass is a an automatic control valve. Both the bypass and bypass valve, shown in Figure 3.1, are in the 75th floor MER, Tower A, but they are typical for all differential bypasses in all MERs in both towers.

The function of the bypass is to compensate for variations in demand on the CHWS by the cooling coils in the HVAC units and the secondary water coolers in the MERs, and still maintain a constant differential pressure between the CHWS and CHWR. The difference in flow rates between the maximum MER demand and a lesser demand is bypassed through the differential pressure bypass.

Piping and Control Valves

The piping of the bypass is sized to carry a maximum of 80% of the total MER flow rate. The design specification calls for the pressure of the CHWS to be 25 PSI higher than the CHWR. A schematic of the bypass and control circuit for the 7th and 75th floors of both towers is in Figure 3.2.

The bypass control valve in the 75th floor MER is a Honeywell 8", type 9201, normally-open, direct-acting, diaphragm-actuated control valve. The differential pressure controller is manufactured by the Moore Controls Company.

The bypass valve in the 7th floor MER is a Honeywell 6", type 9201, normally-open, direct-acting control valve; but the valves in the 41st and 108th floor MERs are Honeywell 6", type 8105. The differential pressure controller in the 7th floor MER is a Moore unit like the one on the 75th floor, but the pressure controllers in the 41st and 108th floor MERs are Honeywell products.

Operation

Except for sizes, capacities, and control systems, all differential bypasses in Towers A and B are similar and operate in a similar manner. See Figures 3.2 and 3.3. Therefore, for reasons of economy and to avoid repetition, the description of the operation of the differential bypass in the 75th floor MER, Tower A, which follows, is considered typical for all differential bypasses in both towers.

At maximum heat load the total flow rate requirement for all cooling coils in the HVAC units, and secondary water coolers in the 75th floor MER, is 8012 GPM. At this flow rate and a differential pressure of 25 PSI, differential bypass valve V17 is closed and no CHWS is being bypassed. See Figure 3.2. At any heat load and flow rate less than 8012 GPM, V17 opens proportionally, and causes a portion of that maximum flow rate to be bypassed.

For example, assume that on a very hot day in August, all cooling coils in the air conditioning supply units and all shells of the secondary water coolers require their maximum flow rate of

CHW. Under these conditions: 8012 GPM will flow into the MER, bypass valve V17 is closed, and no CHWS is being bypassed to the CHWR.

Now, assume that for some reason the outside air temperature drops. The cooling coils in the HVAC supply units and the shells of the secondary converters require less chilled water. Assume that the flow rate decreases to 6012 GPM.

This decrease in demand and flow rate causes the pressure of the CHWS to increase momentarily, thus causing a momentary increase in the pressure differential sensed by reverse-acting differential pressure controller P17. See Figure 3.2. P17 then decreases the pressure of the control air to the diaphragm of bypass valve V17. This decrease in control air pressure causes V17 to open enough to bypass the amount of chilled water required to bring the differential pressure between the CHWS and the CHWR back down to 25 PSI. The flow rate of the chilled water flowing through the bypass will be 2000 GPM.

Now, assume that for some reason the heat load rises again, and the demand for chilled water increases to 7012 GPM. The pressure of the CHWS decreases momentarily, thereby causing a decrease in the pressure differential between the CHWS and the CHWR. This decrease in differential pressure causes controller P17 to increase the pressure of the control air to the diaphragm of differential bypass valve V17. This causes V17 to close proportionally and bypass only 1000 GPM at a differential pressure of 25 PSI.

The chilled water bypass can also be controlled from the central control panel (computer). The central control panel has a switch on it that can override the action of the differential pressure controller and close the bypass valve. This is accomplished via the EPI relay in the Honeywell remote function panel. See Figure 3.2.

When the switch on the central control panel is depressed, Honeywell 28-volt DC power energizes the EPI relay. This connects main air to the diaphragm of the bypass valve via contacts 1 and 3 of the EPI relay, causing the valve to close.

Note that the control circuit shown in Figure 3.2 is valid for the 7th and 75th floor MERS only. The circuits for the 41st and 108th floor MERs are different because they use Honeywell differential pressure controllers rather than Moore controllers, but they operate in a manner similar to that described above. The difference is that the Honeywell differential pressure controller operates the bypass valve directly; it does not require a receiver controller. See Figure 3.3. A photo of the Moore differential pressure controller used in the 7th and 75th floor MERs is in Figure 3.3A. The Honeywell differential pressure controller used in the 41st and 108th floor MERs is shown in Figure 3.3B.

QUICK-FILL AND DRAIN VALVES

For purposes of seasonal changeover, the chilled water systems (high and low) in both towers have quick-fill and drain valves. The low-zone valves and piping are on Elevation 242', and are

described in the WTC O&M Manual "Miscellaneous Electrical and Mechanical Systems".

The quick-fill valves for the high zone are on the upper level of the 75th floor MER. See Figure 3.4. The piping and valves for the Domestic Water System are immediately to the right of the bypass piping in the MER, about 7 feet above floor level. See Figure 3.5. In this photo, note that the spool-piece connection between the domestic water piping and the chilled water piping has been removed. This is done to preclude the possibility of the chilled water backfeeding into the domestic water once the chilled water system has been filled.

EXPANSION TANKS

General

Due to changing temperatures and pressures, the water in the low- and high-zone chilled water systems expands and contracts. For this reason, and to provide head, both zones are equipped with an open expansion tank and assembly.

The expansion tank for the low zone is in a room on the 45th floor, and the tank for the high zone is in the Tank Room on the 110th floor. Both tanks and installations are similar and operate in a similar manner. Consequently, for reasons of economy and to avoid repetition in this manual, only the operation of the high-zone expansion tank assembly is described here, and the description is considered typical for the low-zone assembly. A photograph

of the high-zone assembly is in Figure 3.6, and a schematic of a typical assembly is in Figure 3.7.

Operation

When the CHW in the system expands due to increased temperature or pressure, the excess water moves up into the bottom of the expansion tank. When the CHW contracts, the water drains out of the bottom of the tank back into the system. See Figure 3.7.

Additionally, when due to evaporation and minor leakage, the level of water in the expansion tank drops down below a preset level, the McDonnell Miller Level Control opens and allows DCW to enter the tank. Then, when the level of water rises to the preset level, the Level Control closes again and stops the DCW from entering the tank.

Level Alarms

The expansion tanks are equipped with level alarm switches. See Figures 3.6 and 3.7. If the level of water in the tank goes above the setting of the high-level alarm switch, or drops below the setting of the low-level alarm switch, an alarm is transmitted to the Operations Desk on Level B1.

CHAPTER 4

HVAC SYSTEM

SCOPE

Descriptions of the HVAC System in Towers A and B are detailed in this chapter. It contains operational descriptions of the Peripheral, Interior, Core, Lobby, and Freight and Shuttle Elevator Machine Room HVAC units.

PERIPHERAL HVAC UNITS

General

Sixteen HVAC units in each tower, 4 in each of the 4 MERs, are required to supply primary air to all peripheral areas in both towers, with the exception of the Club/Restaurant on the 106th and 107th floors in Tower A and the Observation Deck on the 107th floor of Tower B. The HVAC unit numbers, the MERs in which the units are, the return air fans they are interlocked with, and the zones they supply are outlined in Table 4.1. A detailed description of the Induction units and their operation is in Chapter 6 of this manual.

Typical Unit

As can be seen in Table 4.1, HVAC unit ACS 7-2, in the 7th floor MER of either tower, supplies primary air to the Induction units on the east peripheral wall of Floors 9 thru 24. Since all Peripheral units in the 7th and 108th floor MERs of both towers are similar, and operate in a similar manner, for reasons of

economy and to avoid repetition, only the operation of unit ACS 7-2, Tower A, is described here, and the description is considered typical for units ACS 7-1, 7-3, 7-4, and 108-1 thru 108-4 in both towers. For the Peripheral Zone supplied by a particular unit, and the return air fan it is interlocked with, refer to Table 4.1, which follows.

Table 4.1

Peripheral HVAC Units - Towers A and B

ACS No.	MER Floor	Peripheral Zone Supplied	Interlocked Return Air Fan (ACR) (Tower A)	(Tower B)
7-1	7	North, Floors 9 thru 24	7-2	7-4
7-2	"	East, " " " "	7-4	7-6
7-3	"	South, " " " "	7-6	7-8
7-4	"	West, " " " "	7-8	7-2
41-1	41	North, Floors 25 thru 58	41-3	41-6
41-2	"	East, " " " "	41-6	41-9
41-3	"	South, " " " "	41-9	41-12
41-4	"	West, " " " "	41-12	41-3
75-1	75	North, Floors 59 thru 91	75-3	75-6
75-2	"	East, " " " "	75-6	75-9
75-3	"	South, " " " "	75-9	75-12
75-4	"	West, " " " "	75-12	75-3
108-1	108	North, Floors 92 thru 106	108-2	108-4
108-2	"	East, " " " "	108-4	108-6
108-3	"	South, " " " "	108-6	108-8
108-4	"	West, " " " "	108-8	108-2

Left and right side views of Peripheral HVAC unit ACS 7-1 in Tower A are in Figures 4.1 and 4.2. Preheat coil piping and steam control valves for unit ACS 7-2 are shown in Figure 4.3. Views of this unit's cooling coil and reheat coil piping are in Figures 4.4 and 4.5, respectively. Schematics of this piping and its associated control valves are in Figures 4.6, 4.7, and 4.8. There are some minor differences in specifications, dimensions, and capacities among units ACS 7-1 thru 7-4 and ACS 108-1 thru 108-4, but these differences do not affect the manner in which they operate.

Since the 8 HVAC units in the 41st and 75th floor MERs supply primary air to Induction units on floors both above and below the MERs (see Figure 1.1), the operation and control circuitry of these units differ slightly from those in the 7th and 108th floor MERs. Accordingly, the description of operation of HVAC unit ACS 41-2, which is typical of the 8 units in the 41st and 75th floor MERs, follows later in this chapter.

Operation
Unit ACS 7-2, Tower A

General. When supply fan ACS 7-2 is not operating, HVAC unit ACS 7-2 is in the following state (see Figure 4.9): outside air dampers D1A and D1B are closed; return air damper D10 is open; preheat coil steam control valves V3 (see Figure 4.3) may be open, closed, or partially open, depending upon the outside air temperature; chilled water control valve V4 (see Figure 4.10), reheat coil steam control valve V5 (see Figure 4.11), and

humidifier steam control valve V6 (see Figure 4.11) are closed; return air fan ACR 7-4 is off; and vortex damper DV7 is closed.

Moreover, if the outside air temperature is above 34 degrees F, chilled water coil freeze protector valve VP4 (see Figure 4.12) is closed and freeze protection pump FP is off. A description of the operation of the freeze protection pump is provided later in this chapter. Note: Though Figures 4.11 thru 4.14 show components on unit ACS 7-1, they are typical for unit ACS 7-2.

The steam supply to the preheat coils is monitored by preheat coil temperature sensors TS3 (see Figures 4.3 and 4.9), one on the downstream side of each coil section (there are 2 coil sections in this unit). These sensors, in conjunction with their preheat coil controllers, which are in the local control panel (LCP), control normally-open preheat coil steam control valves V3. One preheat coil steam control valve is on the inlet side of each preheat coil section. See Figures 4.3 and 4.6. The LCP (see Figures 4.13 and 4.14) is adjacent to HVAC unit ACS 7-2.

Operation of the preheat coil steam control circuits is as follows: when the temperature at sensors TS3 drops below 45 degrees F, the preheat coil controllers in the LCP decrease the control air pressure to preheat steam control valves V3. This causes them to open proportionally and allow more steam to flow through the preheat coils.

The combinations of TS3 and the preheat coil controllers are reset by the Master Outside Air Reset Circuit. This resetting eliminates the throttling range of temperature sensors TS3 and

their controllers, so that a constant leaving air temperature is maintained. (The Master Outside Air Reset Circuit is described in the latter part of this chapter.)

When return air fan ACR 7-4 (see Figure 4.9) in the return air plenum is started, its interlock with supply fan ACS 7-2 is energized. Then, when the Start button for supply fan ACS 7-2 is depressed, the startup relay in the remote function panel (RFP) is energized (see Figure 4.9). Honeywell control air of 18 PSI is applied to minimum outside air and supply fan damper motors M1A and MV7, respectively. Dampers D1A and DV7 start to open. (The RFP is in the same quadrant of the MER as ACS 7-2 and in front of the unit. See Figure 4.15.) When damper D1A has opened a preset amount, limit switch DS, operated by the damper, closes and allows the supply fan to start, and the entire control circuit is set in operation.

Summer Cycle. To set the HVAC unit into summer operation, the Auto/Winter/Summer switch in the relay and control compartment in the RFP must be set to the SUM position. See Figures 4.9 and 4.16. Dew point sensor DPS7, in the supply fan discharge duct, in conjunction with the dew point controller in the LCP, controls chilled water control valve V4 to maintain the dew point air temperature downstream from the cooling coils at 49 degrees F.

Temperature sensor T7, in conjunction with the unit transducer in the RFP (see Figure 4.17) and the cooling coil and reheat coil proportional relays in the LCP, controls, in sequence, reheat coil

steam control valve V5 and chilled water control valve V4, to maintain a scheduled supply air temperature. See Figure 4.9.

Operation of this control circuit is as follows: when the discharge air temperature rises above the setting of the temperature sensor T7/unit transducer combination, the control action of the components mentioned above is to gradually close reheat coil steam control valve V5, and open chilled water control valve V4.

Moreover, if the wet-bulb temperature of the discharge air rises above the setting of the dew point sensor DPS7/dew point controller combination, the action of DPS7, in conjunction with the dew point controller and the selector relay (SR) in the LCP, is to override the effect of sensor T7 on chilled water control valve V4. When this happens, sensor T7, in conjunction with its unit transducer, gradually opens reheat coil steam control valve V5 to maintain the scheduled supply air temperature.

On units ACS 7-1 and 108-1, the sensor T7/unit transducer combination is reset by the Master Outside Air Reset Circuit. On units ACS 7-2, 7-3, 7-4, 108-2, 108-3, and 108-4, the sensor T7/unit transducer combination is reset by a solar-type master reset thermostat. See Figures 4.9, 4.17A, and 4.17B. (The Master Outside Air Reset Circuit is described in the latter part of this chapter.)

Preheat coil steam control valves V3 are under the control of their sensors TS3/preheat coil controller combinations in the LCP. Minimum and maximum outside air dampers D1A and D1B remain closed, and return air damper D10 remains open.

Winter Cycle. To set the HVAC unit into winter operation, the Auto/Winter/Summer switch in the relay and control compartment in the RFP must be set to the WINT position. See Figures 4.9 and 4.16. Sensor T7, in conjunction with the unit transducer in the RFP and the damper proportional relay in the LCP (see Figures 4.9 and 4.14), controls maximum outside air damper D1B and return air damper D10, to maintain a supply air temperature of 50 degrees F.

Minimum outside air damper D1A and supply fan damper DV7 remain open. Chilled water control valve V4 remains under the control of dew point sensor DPS7, in conjunction with the dew point controller in the LCP (see Figures 4.9 and 4.14.), and reheat coil steam control valve V5 remains closed.

Preheat coil steam control valves V3 are under the control of the temperature sensor TS3/preheat coil controller combinations. Dew point sensor DPS7, in conjunction with the humidity controller in the LCP (see Figures 4.9 and 4.14), controls humidifier steam control valve V6 to maintain a scheduled dew point temperature between 32 degrees F and 49 degrees F, as the outside air temperature varies from 0 degrees F to 50 degrees F. A typical humidifier can be seen in Figure 4.18. The sensor DPS7/humidity controller combination is reset by the Master Outside Air Reset Circuit, whose operation is described in the latter part of this chapter.

Freezestat. Low temperature safety thermostat LT4 (Freezestat), located between the preheat coil and the cooling coil (see Figures 4.4 and 4.9), stops the supply fan and energizes an alarm circuit if the air temperature between the preheat coil and the cooling coil drops below 35 degrees F.

Freeze Protection Pump. Included on the HVAC unit is a freeze protection pump (FP) and its associated controls and piping. See Figures 4.9 and 4.12. The function of the FP is to circulate the chilled water through the cooling coils so that the water doesn't freeze when chilled water control valve V4 is closed and the outside air temperature drops below 34 degrees F.

The freeze protection pump is controlled by the Master Outside Air Reset Circuit and associated Honeywell control components in the LCP and RFP. (The Master Outside Air Reset Circuit is described in the latter part of this chapter.)

Some of the criteria to be considered when reviewing the operation of the freeze protection pump are as follows:

1. Honeywell control air line, 6, from the Master Outside Air Reset Panel, is zero PSI when the outside air temperature is below 34 degrees F, and 13 PSI when the out side air temperature is above 34 degrees F. See Fig. 4.9.
2. Honeywell control components in the LCP and RFP keep normally open freeze protector valve VP4 from opening and the freeze protection pump from starting, until chilled water control valve V4 is closed. See Figure 4.9.

For purposes of this description, let us assume 2 different outside air temperatures: one above 34 degrees F and the other below 34 degrees F. At a temperature above 34 degrees F, the following is true (see Figure 4.9):

1. Control air line, 6, from the Master Outside Air Reset Panel, is 13 PSI.
2. The pressure of control air line, 64, is greater than 3.5 PSI. (This is the pressure applied to the diaphragm of chilled water control valve V4 and the freeze protection pump pressure switch in the RFP. See Figure 4.9).
3. Chilled water control valve V4 is open and chilled water is flowing through the cooling coils.
4. The freeze protection pump pressure switch in the RFP is in the open position.
5. The freeze protection pump control relay (FPR) in the RFP is deenergized. Its contacts 2 and 3 are closed. Main control air, 1, is connected to control air line, 74.
6. Normally-open freeze protector valve VP4 is closed.
7. Control air, 74, keeps the freeze pump control switch (FPCS) in the RFP open.
8. The freeze protection pump is off.

When the outside air temperature drops below 34 degrees F the following actions take place:

1. Control air line, 6, from the Master Outside Air Reset Panel, drops to zero PSI.

2. Control air line, 64, pressure is less than 3 PSI. (This is the pressure applied to the diaphragm of chilled water control valve V4 and the freeze protection pump pressure switch in the RFP.)
3. Chilled water control valve V4 closes.
4. The freeze protection pump pressure switch closes.
5. The freeze protection pump control relay (FPR) in the RFP is energized. Its contacts 1 and 3 close.
6. Air signal, 6, which is now zero PSI, is connected to air line, 74.
7. Normally-open freeze protector valve VP4 is open.
8. The zero pressure in air line, 74, causes the FPCS in the RFP to close.
9. The freeze protection pump starts and runs.
10. If, after the freeze protection pump starts, the flow rate of the chilled water is too low, flow switch FS 4 transmits an alarm to the Honeywell central control panel. See Figures 4.9 and 4.19.

Operation
Unit ACS 41-2, Tower A

<u>General</u>. The 16 Peripheral HVAC units in the 41st and 75th floor MERs of both towers supply conditioned primary air to the Induction units on floors above and below these MERs. See Figure 1.1. Inasmuch as all the units in these MERs are similar and operate in a similar manner, for reasons of economy and to avoid repetition in this manual, only the operation of unit ACS 41-2 in

Tower A is described here, and the description is considered typical for units ACS 41-1, 41-3, 41-4, and ACS 75-1 thru 75-4 in both towers. For the Peripheral Zone supplied by a particular unit and the return air fan it is interlocked with, refer to Table 4.1, which was presented earlier in this chapter.

Since unit ACS 41-2 supplies conditioned air to Induction units on floors both above and below the 41st floor MER, the unit has 2 supply ducts and 2 reheat coils. See Figure 4.20. One duct supplies air to Floors 43 thru 58, and the other to Floors 25 thru 40. Moreover, each duct is equipped with a separate reheat coil and complement of sensors. Another difference between units ACS 41-2 and ACS 7-2 is that the reheat coils on unit ACS 41-2 are on the downstream side of the supply fan, while on unit ACS 7-2 the reheat coil is on the upstream side. See Figures 4.9 and 4.20.

When supply fan ACS 41-2 is not operating, HVAC unit ACS 41-2 is in the following state (see Figure 4.20): outside air dampers D1A and D1B are closed; return air damper D10 is open; preheat coil steam control valves V3 (see Figure 4.3) may be open, closed, or partially open, depending upon the outside air temperature; chilled water control valve V4 (see Figure 4.10), reheat coil steam control valves V7, and humidifier steam control valve V6 are closed; return air fan ACR 41-6 is off; and vortex damper DV7 is closed. Moreover, if the outside air temperature is above 34 degrees F, chilled water coil freeze protector valve VP4 (see Figure 4.12) is closed, and freeze protection pump FP is not operating.

The steam supply to the preheat coils is monitored by preheat coil temperature sensors TS3 (see Figures 4.3 and 4.20), one on the downstream side of each coil section. (There are 8 coil sections in this unit.) These sensors, in conjunction with their preheat coil controllers in the LCP, control normally-open preheat coil steam control valves V3.

One preheat coil steam control valve is on the inlet side of each preheat coil section. See Figures 4.3 and 4.6. The preheat coil controllers are in the LCP (see Figures 4.13 and 4.14), and the LCP is adjacent to unit ACS 41-2.

Operation of the preheat coil steam control circuit is as follows: when the temperature at sensors TS3 drops below 45 degrees F, the preheat coil controllers in the LCP decrease the control air pressure to the diaphragms of preheat coil steam control valves V3, causing them to open proportionally and allow more steam to flow through the preheat coils.

The combinations of TS3 and the preheat coil controllers are reset by the Master Outside Air Reset Circuit. This resetting eliminates the throttling ranges of temperature sensors TS3 and their controllers, so that a constant leaving air temperature is maintained downstream of the preheat coils. (The Master Outside Air Reset Circuit is described in the latter part of this chapter.)

When return air fan ACR 41-6 is started, its electrical interlock with supply fan ACS 41-2 is energized. See Figure 4.20. Then, when the Start button for supply fan ACS 41-2 is depressed, the startup relay in the remote function panel (RFP) is energized; Honeywell control air of 18 PSI is applied to minimum outside air and supply fan damper motors M1A and MV7, respectively, and the dampers start to open. (The RFP is in the same quadrant of the MER as unit ACS 41-2, and in front of unit ACS 41-6.) When damper D1A has opened a preset amount, limit switch DS, operated by the damper, closes and allows the supply fan to start, and the entire control circuit is set in operation.

Summer Cycle. To set the HVAC unit into summer operation, the Winter/Summer switch in the relay and control compartment in the RFP must be set to the SUM position. See Figures 4.16 and 4.20. Dew point sensor DPS7 in the supply fan discharge duct, in conjunction with the dew point controller in the LCP, controls chilled water control valve V4 to maintain the dew point air temperature downstream from the cooling coils at 49 degrees F.

Temperature sensors T8 (one in each supply duct), in conjunction with their unit transducers in the RFP, the cooling coil and reheat coil proportional relays in the LCP control, in sequence, reheat coil steam control valves V7 and chilled water control valve V4, to maintain a scheduled supply air temperature. See Figure 4.20.

Operation of this control circuit is as follows: when the discharge air temperature in either discharge duct rises above the setting of the temperature sensor T8/unit transducer combination, control action of the components mentioned above is to gradually close reheat coil steam control valve V7 in the respective duct, and open chilled water control valve V4.

Moreover, if the wet-bulb temperature of the supply air rises above the setting of the dew point sensor DPS7/dew point controller combination, the action of DPS7, in conjunction with the dew point controller and the selector relay (SR) in the LCP, is to override the effect of sensor T8 on chilled water control valve V4. When this occurs sensor T8, in conjunction with its unit transducer, gradually opens its respective reheat coil steam control valve V7, to maintain the scheduled air temperature.

On units ACS 41-1 and 75-1, the combination of sensors T8 and their unit transducers is reset by the Master Outside Air Reset Circuit. On units ACS 41-2, 41-3, 41-4, 75-2, 75-3, and 75-4, the sensor T8/unit transducer combinations are reset by solar-type master reset thermostats. See Figures 4.17A, 4.17B, and 4.20. (The Master Outside Air Reset Circuit is described in the latter part of this chapter.)

Preheat coil steam control valves V3 are under the control of their sensor TS3/preheat coil controller combinations. Minimum and maximum outside air dampers D1A and D1B remain closed, and return air damper D10 remains open.

Winter Cycle. To set the HVAC unit into winter operation, the Auto/Winter/Summer switch in the RFP must be set to the WINT position. See Figures 4.16 and 4.20. Temperature sensors T8, in conjunction with their unit transducers in the RFP and the dampers proportional relay in the LCP, control maximum outside air damper D1B and return air damper D10, to maintain a discharge air temperature of 50 degrees F. Minimum outside air damper D1A and supply fan discharge damper DV7 remain open.

On a rise in temperature above the setting of the sensors T8/unit transducer combinations, control action is to gradually and simultaneously open maximum outside air damper D1B and close return air damper D10. The sensor T8/unit transducer combination calling for the most heating controls the dampers. Dew point sensor DPS7, in conjunction with the dew point controller in the LCP, controls chilled water control valve V4, and reheat coil steam control valves V7 remain closed.

Preheat coil steam control valves V3 are under the control of their sensor T33/preheat coil controller combinations. Dew point sensor DPS7, in conjunction with the humidity controller in the LCP, controls humidifier steam control valve V6 to maintain a scheduled dew point temperature between 32 degrees F and 49 degrees F, as the outdoor air temperature varies from 0 degrees to 50 degrees F. The sensor DPS7/humidity controller combination is reset by the Master Outside Air Reset Circuit, whose operation is described in the latter part of this chapter.

Freezestat. Low temperature safety thermostat LT4 (freezestat), located between the preheat coil and the cooling coil (see Figures 4.4 and 4.20), stops the supply fan and energizes an alarm circuit if the air temperature between the preheat coil and the cooling coil drops below 35 degrees F.

Freeze Protection Pump. The freeze protection pump on unit ACS 41-2 and the pump control circuitry are similar to those of Peripheral HVAC unit ACS 7-2, and operate in a similar manner. Hence, to avoid repetition, a description of the operation of the freeze protection pump for unit ACS 41-2 is not repeated here. For a description of the operation of the freeze protection pump, refer back to the "Freeze Protection Pump" discussion for unit ACS 7-2, provided earlier in this chapter, but note that references to Figure 4.9 in that discussion change to Figure 4.20 for unit ACS 41-2.

INTERIOR HVAC UNITS

General

Twenty-four HVAC units in each tower (4 each in the 7th and 108th floor MERs, and 8 each in the 41st and 75th floor MERs) supply conditioned air to all Interior quadrants in each tower, with the exception of the Club/Restaurant on the 106th and 107th floors in Tower A, and the Observation Deck on the 107th floor in Tower B.

The HVAC unit numbers, the MERs in which they are located, the return air fans they are interlocked with, and the quadrants they serve are listed in Table 4.2, which follows. Movement of the

conditioned air from the HVAC units in the MERs to the Interior quadrants on the floors is described in Chapter 1.

As can be seen in Table 4.2, HVAC unit ACS 41-5, Tower A, supplies conditioned air to the northwest quadrant of Floors 25 thru 40. A partial view of this unit is in Figure 4.21. Since all Interior HVAC units are similar, and operate in a similar manner, for reasons of economy and to avoid repetition, only the operation of unit ACS 41-5, Tower A, is described here and the description is considered typical for all 48 Interior HVAC units in both towers. When considering any other Interior HVAC unit, refer to Table 4.2 for the quadrant it supplies and its interlocked return air fan.

Table 4.2

Interior HVAC Units - Towers A and B

ACS No.	MER Floor	Quadrant Supplied (Tower A)*	Interlocked Return Air Fan (ACR) (Towers A&B)
7-5	7	Northwest, Floors 9 thru 24	7-1
7-6	"	Northeast, " " " "	7-3
7-7	"	Southeast, " " " "	7-5
7-8	"	Southwest, " " " "	7-7
41-5	41	Northwest, Floors 25 thru 40	41-1
41-6	"	Northeast, " " " "	41-5
41-7	"	Southeast, " " " "	41-7
41-8	"	Southwest, " " " "	41-11
41-9	"	Northwest, Floors 44 thru 58	41-2

ACS No.	MER Floor	Quadrant Supplied (Tower A)*					Interlocked Return Air Fan (ACR) (Towers A&B)
41-10	"	Northeast,	"	"	"	"	41-4
41-11	"	Southeast,	"	"	"	"	41-8
41-12	"	Southwest,	"	"	"	"	41-10
75-5	75	Northeast,	Floors	59	thru	74	75-1
75-6	"	Northeast,	"	"	"	"	75-5
75-7	"	Southeast,	"	"	"	"	75-7
75-8	"	Southwest,	"	"	"	"	75-10
75-9	"	Northwest,	Floors	77	thru	91	75-2
75-10	"	Northeast,	"	"	"	"	75-4
75-11	"	Southeast,	"	"	"	"	75-8
75-12	"	Southwest,	"	"	"	"	75-11
108-5	108	Northwest,	Floors	92	thru	106	108-1
108-6	"	Northeast,	"	"	"	"	108-3
108-7	"	Southeast,	"	"	"	"	108-5
108-8	"	Southwest,	"	"	"	"	108-7

* For Tower B, the quadrant supplied by an HVAC unit changes as follows:

Quadrant Supplied (Tower A)		Quadrant Supplied (Tower B)
Northwest	becomes	Southwest
Northeast	"	Northwest
Southeast	"	Northeast
Southwest	"	Southeast

Operation
Unit ACS 41-5, Tower A

General. When supply fan ACS 41-5 is not operating, HVAC unit ACS 41-5 is in the following state (see Figure 4.22): outside air dampers D1A and D1B are closed; supply fan discharge damper D7 is closed; return air damper D10 is open; preheat coil steam control valves V3 may be open, closed, or partially open, depending on the outside air temperature; chilled water control valve V4 and humidifier steam control valve V6 are closed; return air fan ACR 41-1 is off; and if the outside air temperature is above 36 degrees F, chilled water coil freeze protector valve VP4 is closed and freeze protection pump FP is off.

The temperature of the steam supply to the preheat coils is monitored by preheat coil temperature sensors TS3, one on the downstream side of each coil section. (There are 6 coil sections in this unit.) These sensors, in conjunction with their preheat coil controllers in the LCP, control normally-open preheat coil steam control valves V3, one on the inlet side of each preheat coil section.

Operation of this circuit is as follows: when the temperature at sensors TS3 drops below 45 degrees F, the combinations of sensors TS3 and their preheat coil controllers in the LCP decrease the control air pressure to the diaphragms of preheat coil steam control valves V3. This causes the valves to open proportionally and allow more steam to flow through the preheat coils.

The combinations of temperature sensors TS3 and their preheat coil controllers are reset by the Master Outside Air Reset Circuit. This eliminates the throttling range of the controller/sensor combinations, so that a constant air temperature is maintained downstream of the preheat coils. (The Master Outside Air Reset Circuit is described in the latter part of this chapter.)

When return air fan ACR 41-1, which draws air from the northwest return air plenum, is started, its interlock with supply fan ACS 41-5 is energized. Then, when the Start button for supply fan ACS 41-5 is depressed, the minimum damper relay in the remote function panel (RFP) is energized; Honeywell control air of 18 PSI is applied to minimum outside air damper motor M1A; and damper D1A starts to open. (The RFP is in the same quadrant of the MER as HVAC unit ACS 41-5, and in front of unit ACS 41-9.) When damper D1A has opened a preset amount, limit switch DS, operated by the damper, closes and allows the supply fan to start. Fan discharge damper D7 opens and the entire control circuit is set into operation.

<u>Summer Cycle</u>. To set the HVAC unit into summer operation, the Auto/Winter/Summer switch in the RFP must be set to the SUM position. See Figures 4.16 and 4.22. Temperature sensor TS7, in conjunction with the fan discharge controller and the cooling coil proportional relay in the LCP, controls chilled water control valve V4. Temperature sensor TS7 is in the fan discharge duct.

On a rise in temperature above the setting of TS7, control action of the components mentioned above produces increased air pressure on the diaphragm of chilled water control valve V4, causing it to open proportionally. Maximum outside air damper D1B remains closed. Minimum outside air damper D1A and return air damper D10 remain open. Preheat coil steam control valves V3 remain under the control of temperature sensors TS3.

Dew point sensor DPS7, downstream of the supply fan, in conjunction with the dew point controller in the LCP, automatically resets the temperature setting of the combination of temperature sensor TS7 and the fan discharge controller, to maintain the dew point temperature of the discharge air at 49 degrees F.

Winter Cycle. To set the unit into winter operation, the Auto/Winter/Summer switch in the RFP must be set to the WINT position. Temperature sensor TS7, in conjunction with the fan discharge controller and the dampers and cooling coil proportional relays in the LCP, controls, in sequence: preheat coil steam control valves V3, maximum outside air damper D1B, return air damper D10, and chilled water control valve V4, to maintain a discharge air temperature of 51 degrees F.

On a rise in temperature above the setting of the TS7/fan discharge controller combination, control action is to gradually close preheat coil steam control valves V3, then to simultaneously open maximum outside air damper D1B and close return air damper D10 in a gradual action, and finally, open chilled water control

valve V4. The fan discharge controller can be reset locally by means of a control on the controller and remotely by the central control panel, so that the discharge air temperature can be adjusted upward during the winter season for morning pickup.

Dew point sensor DPS7, in conjunction with the humidity controller in the LCP, reset by the Master Outside Air Reset Circuit, controls humidifier steam control valve V6 to maintain a scheduled dew point temperature of 32 degrees F to 49 degrees F, as the outside air temperature varies from 0 degrees to 50 degrees F. (The Master Outside Air Reset Circuit is discussed in the latter part of this chapter.)

<u>Freezestat</u>. Freezestat LT4, between the preheat coil and the cooling coil (see Figure 4.22), stops the supply fan and energizes an alarm circuit if the air temperature between the preheat coil and the cooling coil drops below 35 degrees F.

<u>Freeze Protection Pump</u>. The freeze protection pump on HVAC unit ACS 41-5 and its control circuitry are similar to those of Peripheral HVAC unit ACS 7-2, and operate in a similar manner. For a description of the operation of the freeze protection pump, refer back to the "Freeze Protection Pump" discussion for unit ACS 7-2 in the "Peripheral HVAC Units" section, provided earlier in this chapter, but note that references to Figure 4.9 in that discussion change to Figure 4.22 for unit ACS 41-5.

CORE HVAC UNITS

General

Fourteen Core HVAC units (2 each in the 7th, 41st, and 75th floor MERs, and 1 in the 108th floor MER of both towers) supply conditioned air to all the Core areas in the towers, with the exception of the Club/Restaurant on the 106th and 107th floors of Tower A and the Observation Deck on the 107th floor of Tower B. The HVAC unit numbers, the MERs in which they are located, the area they supply, and the return air fans they are interlocked with are listed in Table 4.3, which follows. Movement of the supply air, after it is discharged from the HVAC units in the MERs, is described in Chapter 1.

Table 4.3

Core HVAC Units

ACS No.	MER Floor	Core Area(s) Supplied (Tower A)*	Interlocked Return Air Fans (ACRs) (Towers A&B)
7-9	7	Floors 2 thru 6	7-1,7-2
7-10	"	East and West Sides Floors 9 thru 24	7-5,7-6
41-13	41	South West Side, Floors 25 thru 58	41-1,41-2,41-3
41-14	"	North East Side, Floors 25 thru 58	41-7,41-8,41-9
75-13	75	South West Side, Floors 59 thru 91	75-1,75-2,75-3
75-14	"	East Side, Floors 59 thru 91 North	75-7,75-8,75-9
108-9	108	East and West Sides, Floors 92 thru 106	108-1,108-2

* For Tower B, the Core Area(a) supplied by an HVAC unit change(s) as follows:

Core Area(s) Supplied (Tower A)		Core Area(s) Supplied (Tower B)
East	becomes	North
West	"	South

As can be seen in Table 4.3, HVAC Unit ACS 7-10, Tower A, provides conditioned air to the east and west sides of the cores of Floors 9 thru 24. Since all core HVAC units are similar and operate in a similar manner, for reasons of economy, and to avoid repetition in this manual, only the operation of unit ACS 7-10 is discussed here, and the discussion is considered typical for all Core HVAC units.

A view of the piping for the steam, preheat and reheat coils of HVAC unit ACS 7-10 is in Figure 4.23.

Operation
Unit ACS 7-10, Tower A

General. When supply fan ACS 7-10 is not operating, HVAC unit ACS 7-10 is in the following state (see Figure 4.24): outside air dampers D1A and D1B are closed; return air damper D10 is open; supply fan discharge damper D7 is closed; preheat coil steam control valves V3 may be open, closed, or partially open, depending on the outside air temperature; chilled water control valve V4, reheat coil steam control valve V5, and humidifier steam control valve V6 are all closed; and return air fans ACR 7-5 and 7-6 are

off. Moreover, if the outside air temperature is above 34 degrees F, chilled water coil freeze protector valve VP4 is closed and freeze protection pump FP is off.

The steam supply to the preheat coils is monitored by preheat coil temperature sensors TS3, one on the downstream side of each coil section. (There are 4 coil sections in this unit.) These sensors, in conjunction with the preheat coil controllers in the LCP, control normally-open preheat coil steam control valves V3, one on the inlet side of each preheat coil section. See Figures 4.3 and 4.6.

Operation of this circuit is as follows: when the temperature at sensors TS3 drops below 45 degrees F, the preheat coil controllers (see Figure 4.25) decrease control air pressure to normally open preheat coil steam control valves V3, causing them to open proportionally and allow more steam to flow through the preheat coils.

The combinations of TS3 and their preheat coil controllers are reset by the Master Outside Air Reset Circuit. This resetting eliminates the throttling range of the sensor/controller combinations so that a constant air temperature is maintained downstream of the preheat coils. (The Master Outside Air Reset Circuit is described in the latter part of this chapter.)

When return air fan ACR 7-5 or 7-6, in the southeast return air plenum, is started, its interlock with supply fan ACS 7-10 is closed. Then, when the Start button for supply fan ACS 7-10 is depressed, the system relay in the remote function panel (RFP) is

energized, Honeywell control air of 18 PSI is applied to minimum outside air damper motor M1A, and damper D1A starts to open. (The RFP is in the same quadrant of the MER as HVAC unit ACS 7-10, and in front of HVAC unit ACS 7-7.)

When damper D1A has opened a preset amount, limit switch DS, operated by the damper, closes and allows the supply fan to start. Fan discharge damper D7 opens and the entire control circuit is set into operation.

Summer Cycle. For summer operation, the Auto/Winter/Summer switch in the RFP must be set to the SUM Position. See Figures 4.16 and 4.24. Temperature sensor T7, in conjunction with the unit transducer in the RFP, controls in sequence reheat coil steam control valve V5 and chilled water control valve V4, to maintain an adjustable room air temperature. The sensor T7/unit transducer combination is reset by area temperature sensor T9 and the unit transducer.

Operation of this circuit is as follows: on a rise in temperature above the setting of the sensor T7/unit transducer combination, the unit transducer, in conjunction with the reheat coil and cooling coil proportional relays in the LCP, gradually closes reheat coil steam control valve V5, and then gradually opens chilled water control valve V4.

Simultaneously, if the wet-bulb temperature rises above 53 degrees F, the action of DPS7, in conjunction with the dew point controller and the selector relay (SR) in the LCP (see Figures

4.24 and 4.25), is to override the effect of sensor T7 on chilled water control valve V4, causing it to open.

Maximum outside air damper D1B remains closed, and minimum outside air damper D1A and return air damper D10 remain open. Preheat coil steam control valves V3 remain under the control of the sensors TS3/preheat coil controller combinations.

Winter Cycle. For winter operation, the Auto/Winter/Summer switch in the RFP must be set to the WINT position. Temperature sensor T7, in conjunction with the unit transducer in the RFP, controls in sequence: reheat steam control valve V5, maximum outside air damper D1B, return air damper D10, and chilled water control valve V4, to maintain an adjustable room air temperature.

Operation of the controls mentioned above is as follows: on a rise in temperature above the setting of the sensor T7/unit transducer combination, the unit transducer, in conjunction with the reheat coil and dampers proportional relays in the LCP, gradually closes reheat coil steam control valve V5; simultaneously opens maximum outside air damper D1B; closes return air damper D10 in a gradual action; and gradually opens chilled water control valve V4. The sensor T7/unit transducer combination is reset by area temperature sensor T9 and the unit transducer.

At the same time, if the wet-bulb temperature rises above 53 degrees F, dew point sensor DPS7, in conjunction with the dew point controller and selector relay SR in the LCP, operates in the same manner as in the summer cycle, described earlier. Preheat

coil steam control valves V3 remain under the control of temperature sensors TS3.

Dew point sensor DPS7, in conjunction with the humidity controller in the LCP, also controls humidifier steam control valve V6, to maintain a scheduled dew point temperature of 32 degrees F to 40 degrees F, as the outdoor air temperature varies from 0 degrees to 50 degrees F. The sensor DPS7/humidity controller combination is reset by the Master Outside Air Reset Circuit, which is described in the latter part of this chapter.

Freezestat. Freezestat LT4, between the preheat coil and the cooling coil (see Figure 4.24), stops the supply fan and energizes an alarm circuit if the air temperature between the preheat coil and the cooling coil falls below 35 degrees F.

Freeze Protection Pump. The freeze protection pump on HVAC unit ACS 7-10 and its control circuitry are similar to those of Peripheral unit ACS 7-2, and operate in a similar manner. For a description of the operation of the freeze protection pump, refer back to the "Freeze Protection Pump" discussion for unit ACS 7-2 in the "Peripheral HVAC Units" section provided earlier in this chapter, and note that references to Figure 4.9 in that discussion change to Figure 4.24 for unit ACS 7-10.

FREIGHT AND SHUTTLE
ELEVATOR MACHINE ROOM HVAC UNITS

General

There are 5 HVAC units that cool and heat the freight and shuttle elevator machine rooms (EMRs) in each tower. The MERs in which the HVAC units are located, the EMRs they cool and heat, and the exhaust fans they are interlocked with are listed in Table 4.4, which follows. Circulation of air to and from the HVAC units is described in Chapter 1.

Table 4.4

Elevator Machine Room HVAC Units
Towers A and B

ACS No.	MER Floor	EMRs Cooled (Tower A)*	Interlocked Exhaust Fan (E) (Towers A&B)
41-15	41	Floor 46 (West sector shuttles)	41-17
41-16	41	Floor 42 (Freight Elevator No.48) Floor 46 (East sector shuttles)	41-17
75-15	75	Floor 80 (West sector shuttles)	None
75-16	75	Floor 76 (Freight Elevator No.49) Floor 81 (East sector shuttles)	None
108-10	108	Floor 109 (Shuttle Elevs. Nos.6 & 7) (Freight Elevs. Nos.50&99)	108-11

* For Tower B, the shuttle elevator sectors change as follows:

Sector (Tower A)		Sector (Tower B)
West	becomes	South
East	"	North

As can be seen in Table 4.4, HVAC units ACS 41-15, in the 41st floor MER of both towers, cool and heat the west shuttle EMR on

the 46th floor in Tower A and the south shuttle EMR on the 46th floor in Tower B. Since this HVAC unit is similar to all 10 EMR units, except for physical dimensions and other specifications, for reasons of economy and to avoid repetition, only the operation of unit ACS 41-15 in Tower A is discussed in this chapter, and the discussion is considered typical for all EMR units in both towers. Left and right side views of unit ACS 41-15 are in Figures 4.26 and 4.27, respectively.

Operation
Unit ACS 41-15, Tower A

General. When supply fan ACS 41-15 is not operating, HVAC unit ACS 41-15 is in the following state (see Figure 4.28): outside air damper D1B and fan discharge damper D7 are closed; return air damper D10 is open; preheat coil steam control valve V3 may be open, closed, or partially open, depending on the outside air temperature; chilled water control valve V4 is closed; and if the outside air temperature is above 34 degrees F, chilled water coil freeze protector valve VP4 is closed and freeze protection pump FP is not operating.

The steam supply to the preheat coil is monitored by preheat coil temperature sensor TS3, on the downstream side of the preheat coil. (Some EMR HVAC units have more than 1 preheat coil section.) Sensor TS3, in conjunction with the preheat coil controller in the LCP, controls normally-open preheat coil steam control valve V3, on the inlet side of the preheat coil. See Figure 4.6.

Operation of this circuit is as follows: when the temperature at sensor TS3 drops below 45 degrees F, the preheat coil controller in the LCP (see Figures 4.28 and 4.29) decreases the control air pressure to preheat coil steam control valve V3, causing it to open proportionally and allow more steam to flow through the preheat coil.

The combination of temperature sensor TS3 and the preheat coil controller is reset by the Master Outside Air Reset Circuit. This eliminates the throttling range of the sensor/controller combination so that a constant air temperature is maintained downstream of the preheat coils. (The Master Outside Air Reset Circuit is described in the latter part of this chapter.)

When exhaust fan E41-17, above the Motor Generator Room in the 41st floor MER is started, the interlock with supply fan ACS 41-15 is energized. Then, when the Start button for the supply fan is depressed, the system relay in the RFP is energized. Honeywell control air of 18 PSI is applied to discharge air damper motor M7 and damper D7 starts to open. When the damper has opened a preset amount, limit switch DS, operated by the damper, closes and allows the supply fan to start, and the entire control circuit is set in operation.

Summer Cycle. To set the HVAC unit into summer operation, the Auto/Winter/Summer switch in the RFP must be set to the SUM position. See Figure 4.28. Temperature sensor T7 in the supply fan discharge duct, in conjunction with the unit transducer in the

RFP and the cooling coil proportional relay in the LCP, controls chilled water control valve V4 to maintain an adjustable room air temperature. The sensor T7/unit transducer combination is reset by the combination of room temperature sensor T9 and the same unit transducer.

Operation of this circuit is as follows: On a rise in temperature above the setting of the sensor T7/unit transducer combination, control action is to gradually open chilled water control valve V4. Outside air damper D1B remains closed and return air damper D10 remains open. Preheat coil steam control valve V3 remains under the control of the sensor TS3/preheat coil controller combination.

Winter Cycle. To set the HVAC unit into winter operation, the Auto/Winter/Summer switch in the RFP must be set to the WINT position. See Figure 4.28. Sensor T7, in the supply fan discharge duct, in conjunction with the unit transducer in the RFP, the preheat coil controller, and the dampers and cooling coil proportional relays in the LCP controls, in sequence: preheat coil steam control valve V3; outside air damper D1B; return air damper D10; and chilled water control valve V4, to maintain an adjustable room air temperature.

On a rise in temperature above the setting of the sensor T7/unit transducer combination, control action is to: gradually close preheat coil steam control valve V3 with the setting of the sensor TS3/preheat coil controller combination acting as a low

limit; simultaneously open outside air damper D1B and close return air damper D10 in a gradual action: and gradually open chilled water control valve V4.

Freezestat. Freezestat LT4, between the preheat coil and cooling coil (see Figure 4.28), stops the supply fan and energizes an alarm circuit if the air temperature between the preheat coil and the cooling coil drops below 35 degrees F.

Freeze Protection Pump. The freeze protection pump on HVAC unit ACS 41-15 and its control circuitry are similar to those of Peripheral HVAC unit ACS 7-2, and operate in a similar manner. Hence, for a description of the operation of the unit ACS 41-15 freeze protection pump, refer back to the "Freeze Protection Pump" discussion for unit ACS 7-2 in the "Peripheral HVAC Units" section provided earlier in this chapter, but note that references to Figure 4.9 in that discussion change to Figure 4.28 for unit ACS 41-15.

RETURN AIR FANS

General

There is a total of 45 return air fans in the HVAC System in each tower. Sixteen of these fans are the centrifugal type and 29 are the in-line type. There are 4 centrifugal fans in each of the 2 return air plenums in the 7th and 108th floor MERs. See Figure 4.30. Twelve in-line fans are in the 41st floor MER and 12 are in the 75th floor MER. See Figure 4.31.

Five in-line fans are also in the 7th floor MER: 1 of these fans is for the Core HVAC unit that serves the 2nd thru 6th floors, and 4 are for the lobby HVAC Systems. For a description of the flow of return air from each floor, refer to Chapter 1. For a listing of all the return air fans, their types, locations, areas they serve, and the supply fans they are interlocked with, refer to Table 4.5 which follows.

Table 4.5

Return Air Fans
Towers A and B

ACR No.	MER Floor	Quadrant Returned From (Tower A)**	Interlocked ACS Fan (Tower A)	Interlocked ACS Fan (Tower B)
7-1*	7	Northwest Quadrant, Floors 9 thru 24	7-5,7-9	7-5,7-9
7-2*	"	Northwest Quadrant, Floors 9 thru 24	7-1,7-9	7-4,7-9
7-3*	"	Northeast Quadrant, Floors 9 thru 24	7-6	7-6
7-4*	"	Northeast Quadrant, Floors 9 thru 24	7-2	7-1
7-5*	"	Southeast Quadrant, Floors 9 thru 24	7-7,7-10	7-7,7-10
7-6*	"	Southeast Quadrant, Floors 9 thru 24	7-3,7-10	7-2,7-10
7-7*	"	Southwest Quadrant, Floors 9 thru 24	7-8	7-8
7-8*	"	Southwest Quadrant, Floors 9 thru 24	7-4	7-3
7-9	"	Core, Floors 2 thru 6	None	None
7-10	"	North and West Lobby, Plaza Level	7-11	7-11
7-11	"	South and East Lobby, Plaza Level	7-12	7-12
7-12	"	Lobby Interior, Plaza Level	7-13	7-13
7-13	"	Lobby, Concourse Level	7-14	7-14

ACR No.	MER Floor	Quadrant Returned From (Tower A)**	Interlocked ACS Fan (Tower A)	Interlocked ACS Fan (Tower B)
41-1	41	Northwest Quadrant, Floors 25 thru 58	41-5,41-13	41-5,41-13
41-2	"	Northwest Quadrant, Floors 25 thru 58	41-9,41-13	41-9,41-13
41-3	"	Northwest Quadrant, Floors 25 thru 58	41-1,41-13	41-4,41-13
41-4	"	Northeast Quadrant, Floors 25 thru 58	41-10	41-10
41-5	"	Northeast Quadrant, Floors 25 thru 58	41-6	41-6
41-6	"	Northeast Quadrant, Floors 25 thru 58	41-2	41-1
41-7	"	Southeast Quadrant, Floors 25 thru 58	41-7,41-14	41-7,41-14
41-8	"	Southeast Quadrant, Floors 25 thru 58	41-11,41-14	41-11,41-14
41-9	"	Southeast Quadrant, Floors 25 thru 58	41-3,41-14	41-2,41-14
41-10	"	Southwest Quadrant, Floors 25 thru 58	41-12	41-12
41-11	"	Southwest Quadrant, Floors 25 thru 58	41-8	41-8
41-12	"	Southwest Quadrant, Floors 25 thru 58	41-4	41-3
75-1	75	Northwest Quadrant, Floors 59 thru 91	75-5,75-13	75-5,75-13
75-2	"	Northwest Quadrant, Floors 59 thru 91	75-9,75-13	75-9,75-13
75-3	"	Northwest Quadrant, Floors 59 thru 91	75-1,75-13	75-4,75-13
75-4	"	Northeast Quadrant, Floors 59 thru 91	75-10	75-10
75-5	"	Northeast Quadrant, Floors 59 thru 91	75-6	75-6
75-6	"	Northeast Quadrant, Floors 59 thru 91	75-2	75-1
75-7	"	Southeast Quadrant, Floors 59 thru 91	75-7,75-14	75-7,75-14
75-8	"	Southeast Quadrant, Floors 59 thru 91	75-11,75-14	75-11,75-14
75-9	"	Southeast Quadrant, Floors 59 thru 91	75-3,75-14	75-2,75-14
75-10	"	Southwest Quadrant, Floors 59 thru 91	75-8	75-8
75-11	"	Southwest Quadrant, Floors 59 thru 91	75-12	75-12
75-12	"	Southwest Quadrant, Floors 59 thru 91	75-4	75-3

ACR No.	MER Floor	Quadrant Returned From (Tower A)**	Interlocked ACS Fan (Tower A)	Interlocked ACS Fan (Tower B)
108-1*	108	Northwest Quadrant, Floors 92 thru 106	108-5,108-9	108-5,108-9
108-2*	"	Northwest Quadrant, Floors 92 thru 106	108-1,108-9	108-4,108-9
108-3*	"	Northeast Quadrant, Floors 92 thru 106	108-6	108-6
108-4*	"	Northeast Quadrant, Floors 92 thru 106	108-2	108-1
108-5*	"	Southeast Quadrant, Floors 92 thru 106	108-7	108-7
108-6*	"	Southeast Quadrant, Floors 92 thru 106	108-3	108-2
108-7*	"	Southwest Quadrant, Floors 92 thru 106	108-8	108-8
108-8*	"	Southwest Quadrant, Floors 92 thru 106	108-4	108-3

* Indicates centrifugal-type fan.
All others are in-line type.

** The data for a return air fan in Tower B are identical to the data for a fan of the same designation in Tower A, except for the "Quadrant Returned From". For Tower B, the quadrants change as follows:

Quadrant (Tower A)		Quadrant (Tower B)
Northwest	becomes	Southwest
Northeast	"	Northwest
Southeast	"	Northeast
Southwest	"	Southeast

Operation

General. The control system for all return air fans, except the Lobby return air fans, is similar and operates in a similar manner regardless of the type, physical dimensions, and quantity

of fans in each MER. A schematic of the return air fan control system for the 7th floor MER, Tower A, is in Figure 4.32.

For reasons of economy and to avoid repetition, this figure and the following description are considered typical for the control systems for all return air fans in all MERs in both towers.

A summary of the pertinent information regarding the operation of all the return air fans is as follows (see Figure 4.32):

1. When a return air fan is not operating, its discharge damper (DP10) remains closed, and the supply fan(s) it is interlocked with cannot be started.
2. When a return air fan is started, its respective damper relay in the RFP is energized and Honeywell control air is applied to the damper motor (MP10), causing the damper to open.
3. The spill air damper (DP11), at either end of the spill plenum, is controlled by an industrial-type, indicating, static pressure regulator that operates in conjunction with a duct static head, an outdoor static head, and a pressure sensor. See Figure 4.32. A typical indicating static pressure regulator can be seen in Figure 4.29. The function of this control system and the spill air dampers is to maintain an adjustable static pressure in the spill air plenum that is referenced to the outdoor static pressure.

The outdoor static heads are mounted on the same side of the building as the spill air damper they control. The static pressure regulators are capable of indicating static pressure in a range of -1.0 to +1.0, in tenth of an inch increments, and have an adjustable operating range of 0 to 150 per cent of span.

4. Static pressure switches in the respective return air shafts stop the return air fans if the pressure within the shafts drops below the settings on the pressure switches.

5. A firestat (HT10) is on the downstream side of all centrifugal-type return air fans in the 7th and 108th floor MERs, and on the upstream side of the in-line type fans in the 7th, 41st, and 75th floor MERs. The function of the firestat is to shut off the return air fan and issue an alarm if the temperature of the return air rises above 125 degrees F.

EXHAUST FANS

General

As stated in Chapter 1, air from certain areas in the towers is not included in the return air used by the HVAC units supplying those areas. These areas include the Core, and the shuttle, freight, and local EMRs.

Air from the Core areas is vented through the doors of the ladies' and men's toilets, and exhausted from the towers via the toilet exhausts. Air from the shuttle, freight, and local EMRs is exhausted from the towers via EMR exhaust fans.

The MERs receive their supply air from diffusers in the spill air plenums in the MERs, and air is exhausted from the MERs via MER exhaust fans. Air is also drawn from the MERs into the electrical substations via a louver in a wall of the substation, and exhausted from the substation via an exhaust fan.

There is a total of 68 base-building exhaust fans in the ventilating systems in both towers. Forty-two of the fans are the in-line type and 26 are the centrifugal-type. The centrifugal fans are used for all the electrical substations and the 108th floor MER. The in-line type fans are used for all other applications.

A listing of the exhaust fans, the MERs they are in, the areas they exhaust air from, and the supply fans some of them are interlocked with is in Table 4.6, which follows.

Table 4.6

Exhaust Fans
Towers A and B

Fan No.	Area(s) Exhausted (Tower A)**	MER Floor	Interlocked ACS Fan (Towers A&B)
E-7-14	West Toilets, Floors 9 thru 24	7	—
E-7-15	East Toilets, Floors 9 thru 24	7	—
E-7-16	Sublevel Toilets	7	—
E-7-17	Local EMR, Bank A, Floor 17	7	—
E-7-18	West Side of MER	7	—
E-7-19	East Side of MER	7	—
E-7-20*	North Electric Substation	7	—
E-7-21*	South Electric Substation	7	—
E-41-13	West Toilets, Floors 25 thru 58	41	—
E-41-14	East Toilets, Floors 25 thru 58	41	—
E-41-15	Local EMRs, Banks C and D, Floors 33 and 41	41	—
E-41-16	Local EMRs, Banks A & B, Floors 25 and 56	41	—
E-41-17	East and West Shuttle and Freight EMRs - Floors 41 and 47	41	ACS41-15 ACS41-16
E-41-18	West Side of MER	41	—
E-41-19	East Side of MER	41	—
E-41-20*	North Electric Substation	41	—
E-41-21*	South Electric Substation	41	—
E-75-13	West Toilets Floors 59 thru 91	75	—

Fan No.	Area(s) Exhausted (Tower A)**	MER Floor	Interlocked ACS Fan (Towers A&B)
E-75-14	East Toilets Floors 59 thru 91	75	--
E-75-15	Local EMRs, Banks C and D, Floors 68 and 76	75	--
E-75-16	Local EMRs, Banks A and B, Floors 62 and 87	75	--
E-75-17	West Shuttle EMR, Floor 81	75	--
E-75-18	East Shuttle EMRs Floors 75 and 81	75	--
E-75-19	West Side of MER	75	--
E-75-20	East Side of MER	75	--
E-75-21*	North Electric Substation	75	--
E-75-22*	South Electric Substation	75	--
E-108-9*	East and West Toilets Floors 92 thru 106	108	--
E-108-10*	Local EMRs, Banks B, C, and D, Floors 94, 101, and 108	108	--
E-108-11*	Freight & Shuttle EMRs, 109th Fl.	108	108-10
E-108-12*	West Side of MER	108	--
E-108-13*	East Side of MER	108	--
E-108-14*	North Electric Substation	108	--
E-108-15*	South Electric Substation	108	--

* Indicates centrifugal-type fan.
All others are in-line type.

** All data for the exhaust fans in Tower B are identical to the data for the fan of the same designation in Tower A, except that the compass designations of the areas exhausted change as follows:

Tower A		Tower B
West	becomes	South
East	"	North
North	"	West
South	"	East

Operation

General. The exhaust fans for the toilets, MERs, and EMRs in all MERs, except the 108th floor MER, exhaust into common plenums in the MERs. Moreover, the control systems for these fans are similar and operate in a similar manner. Hence, for reasons of economy and to avoid repetition, the control system for the exhaust fans discharging into the east plenum in the 41st floor MER of Tower A is described here; and the description is considered typical for all the exhaust fans with similar functions in the 7th, 41st, and 75th floor MERs of both towers. See Figure 4.33.

All the exhaust fans in the 108th floor MERs and the exhaust fans for the electric substations in the 7th, 41st, and 75th floor MERs do not exhaust into common plenums. Moreover, the control systems for these fans are similar to each other, but differ from the system shown in Figure 4.33. For this reason, the control system for the exhaust fan for the north electric substation in the 41st floor MER, which is typical for the fans for all electric substations in the 7th, 41st, and 75th floor MERs; and the toilet, EMR, and MER exhaust fans in the 108th floor MER, is provided in Figure 4.34.

The exhaust fans for the electric substations in the 108th floor MERs exhaust on 2 opposite sides of the towers, and their control system differs slightly from that of all the other exhaust fans. Hence, the control system for the 108th floor north electric substation's exhaust fan, which is typical for the fan for the south electric substation, is shown in Figure 4.35. Descriptions of the operation of the control systems for all the exhaust fans are provided in the pargraphs that follow.

EMR, Toilet, and MER Exhaust Fans
7th, 41st, and 75th Floor MERs

Some of the pertinent information regarding the operation of the EMR, toilet, and MER exhaust fans in the 7th, 41st, and 75th floor MERs is as follows (see Figure 4.33):

1. When an exhaust fan is not operating, its respective discharge damper D11A is closed.
2. If none of the fans exhausting into the plenum is operating, plenum discharge dampers D11B are closed.
3. Upon the startup of any exhaust fan in the group, its discharge damper D11A opens and all plenum discharge dampers D11B open. Moreover, dampers D11B remain open as long as at least one fan is operating.
4. A duct-type firestat, HT11, in the duct upstream from each exhaust fan, stops the fan if the temperature of the intake air exceeds 125 degrees F.

Operation of the control systems for these fans is as follows (see Figure 4.33):

1. When an exhaust fan Start button on an MCC is depressed, its respective EP1 relay in the RFP is energized.
2. Honeywell control air is connected to the fan damper motor M11A, and its discharge damper D11A opens.
3. Honeywell control air is also applied to relay R1 in the RFP, which then applies the control air to plenum damper motor M11B. This causes plenum discharge damper D11B to open.
4. Upon the shutdown of all exhaust fans, the EP1 relays in the RFP deenergize and the Honeywell control air is removed from damper motors M11A and M11B, and all dampers return to their normally closed positions.

Electric Substation Exhaust Fans
7th, 41st, And 75th Floor MERs

Operation of the control systems for the electric substation exhaust fans in the 7th, 41st, and 75th floor MERs is as follows (see Figure 4.34):

1. When the fan Start button on the MCC is depressed, the EP1 relay in the RFP is energized.
2. Honeywell control air is connected to fan discharge damper motor M11A and damper D11A opens.
3. When the exhaust fan Stop button is depressed, the EP1 relay relay in the RFP deenergizes, the Honeywell control air is

removed from the fan discharge damper motor, and damper D11A returns to its normally closed position.

4. Firestat HT11, in the duct upstream from the exhaust fan, stops the fan if the intake air temperature exceeds 125 degrees F.

EMR, Toilet, and MER Exhaust Fans
108th Floor MERs

The control systems for the EMR, toilet, and MER exhaust fans in the 108th floor MERs operate in an identical manner to the control systems for the electric substation exhaust fans in the 7th, 41st, and 75th floor MERs. Refer back to this description, which immediately precedes this paragraph, and see Figure 4.34.

Electric Substation Exhaust Fans
108th Floor MERS

Operation of the control systems for the electric substation exhaust fans in the 108th floor MERs is as follows (see Figure 4.35):

1. When the fan Start button in the MCC is depressed, the EP1 relay in the RFP is energized.
2. Honeywell control air is connected to fan discharge damper motors M11A and M11B, and fan discharge dampers D11A and D11B open.
3. When the fan Stop button is depressed, the EP1 relay in the RFP deenergizes, the Honeywell control air is removed from the fan discharge damper motors, and dampers D11A and D11B return to their normally closed positions.

4. Firestat HT11, in the duct upstream from the exhaust fan, stops the fan if the intake air temperature exceeds 125 degrees F.

MAIN LOBBY HVAC SYSTEMS

General

The main lobbies of both towers are cooled and heated by 4 HVAC units. These units are in the 7th floor MER. Their numerical designations are: ACS 7-11, ACS 7-12, ACS 7-13, and ACS 7-14.

HVAC unit ACS 7-11 in Tower A supplies conditioned air to the north and west sides of the lobby at the Concourse level via linear diffusers. These diffusers discharge downward from the underside of the mezzanine overhang at the north perimeter wall and the west window wall. Conditioned air from unit ACS 7-11 also discharges upward at the Plaza level via linear diffusers in the mezzanine floor at the north perimeter wall and the west window wall. HVAC unit ACS 7-12 in Tower A supplies conditioned air to the south and east sides of the lobby, in the same manner as unit ACS 7-11 supplies air to the north and west sides.

HVAC unit ACS 7-11 in Tower B supplies conditioned air to the south and west sides of the lobby at the Concourse level via linear diffusers. These diffusers discharge downward from the underside of the mezzanine overhang at the west perimeter wall and the south window wall. Conditioned air from unit ACS 7-11 also discharges upward at the Plaza level via linear diffusers in the mezzanine floor at the west perimeter wall and the north window

wall. HVAC unit ACS 7-12 in Tower B supplies conditioned air to the north and east sides of the lobby in the same manner as unit ACS 7-11 supplies air to the south and west sides.

HVAC unit ACS 7-13 in both towers supplies conditioned air to the center of the lobby via linear diffusers discharging downward from the top of each shuttle elevator entrance. HVAC unit ACS 7-14 in both towers also supplies conditioned air to the interior of the lobby in the following manner: via linear diffusers discharging downward from the Plaza level at all 4 perimeter walls; via linear diffusers discharging downward from the top of each shuttle elevator entrance; via linear diffusers in the main corridor and the corridors for the 4 local elevator banks; and via linear diffusers discharging upward at the Concourse level at the west perimeter wall in Tower A and at the south perimeter wall in Tower B.

Return air for all of the lobby HVAC units is drawn from a plenum formed by the drop ceiling of the lobby (6th floor). The air is drawn into the plenum via registers encompassing the chandeliers.

Unit ACS 7-11, Tower A

General. As noted earlier in this chapter, HVAC units ACS 7-11 and ACS 7-12 in both towers supply conditioned air to the lobby at the second floor perimeter wall. In addition to their similar functions, HVAC units ACS 7-11 and 7-12 have similar control systems.

Consequently, for reasons of economy and to avoid repetition, only the operation of HVAC unit ACS 7-11 , Tower A, is described here, and the description is considered typical for HVAC units ACS 7-11 and 7-12 in both towers. There are some minor variations amongst these units, but these differences have to do only with the compass directions of air flows, locations, and ducts. The variations are described later in this chapter under the headings "HVAC Unit ACS 7-12, Tower A", and "HVAC Units 7-11 and 7-12, Tower B". A view of the left side of HVAC unit ACS 7-11, Tower A, is in Figure 4.36.

Operation. When supply fan ACS 7-11 is not operating, HVAC unit ACS 7-11 is in the following state (see Figure 4.37): outside air dampers D1A and D1B and spill air dampers D11A and D11B are closed; return air damper D10 is open; preheat coil steam control valve V3 may be open, closed, or partially open, depending on the outside air temperature; chilled water control valve V4, humidifier steam control valve V6, and reheat coil steam control valves V8 are closed; return air fan ACR 7-10 is off; and if the outside air temperature is above 34 degrees F, chilled water coil freeze protector valve VP4 is closed and freeze protection pump FP is not operating. The north wall reheat coil steam control valve and piping can be seen in Figure 4.38.

Steam supply to the preheat coils is monitored by preheat coil temperature sensors TS3, one on the downstream side of each coil section. (There are 6 coil sections in this unit.) These sensors,

in conjunction with their preheat coil controllers in the LCP, control normally-open preheat coil steam control valves V3, one on the inlet side of each preheat coil section. See Figures 4.3 and 4.6. The preheat coil controller is in the LCP. See Figure 4.37.

Operation of this circuit is as follows: when the temperature at sensors TS3 drops below 45 degrees F, the preheat coil controllers decrease the control air pressure to preheat steam control valves V3, causing them to open and allow more steam to flow through the preheat coils.

The combinations of temperature sensors TS3 and their preheat coil controllers are reset by the Master Outside Air Reset Circuit. This eliminates the throttling range of the controller/sensor combinations so that a constant air temperature is maintained downstream of the preheat coils. (The Master Outside Air Reset Circuit is described in the latter part of this chapter.)

When return air fan ACR 7-10 is started, its interlock with supply fan ACS 7-11 is energized. Then, when the Start button for supply fan ACS 7-11 is depressed, the minimum damper relay in the RFP is energized. Honeywell control air of 18 PSI is applied to minimum outside air damper motor M1A and spill air damper motor M11A, and dampers D1A and D11A start to open. (The RFP is in the same quadrant of the MER as unit ACS 7-11, near HVAC unit ACS 7-8.) When minimum outside air damper D1A has opened a preset amount, a limit switch operated by the damper allows supply fan ACS 7-11 to start, and the entire control system is set into operation.

Summer Cycle. To set the HVAC unit into summer operation, the Auto/Winter/Summer switch in the RFP must be set to the SUM position. See Figure 4.37. Temperature sensor TS8, in the north supply duct, in conjunction with the reheat controller in the LCP, controls in sequence reheat coil steam control valve V8 on the north duct and chilled water control valve V4, to maintain an adjustable room air temperature. Additionally, room sensor T9, on the north wall of the lobby, in conjunction with its unit transducer in the RFP, simultaneously resets the set point of the temperature sensor TS7/discharge controller combination in HVAC unit ACS 7-13. See Figures 4.37 and 4.39.

On a rise in temperature above the setting of the temperature sensor TS8/reheat controller combination, control action is to gradually close north duct reheat coil steam control valve V8, then gradually open chilled water control valve V4.

On a rise in temperature above the setting of the north wall temperature sensor T9/unit transducer combination or the west wall sensor T9/unit transducer combination, control action is to first gradually close the north and/or west duct reheat coil steam control valves V8, then to lower the fan discharge temperature of HVAC unit ACS 7-13 (see Figure 4.39), and finally, gradually open chilled water control valve V4 on HVAC unit ACS 7-11. The sensor T9/unit transducer combination calling for the most cooling controls the resetting of unit ACS 7-13 and chilled water control valve V4, on unit ACS 7-11.

In addition, dew point sensor DPS7, downstream of the supply fan, in conjunction with the dew point controller and the SR in the LCP, can assume control of chilled water control valve V4 to maintain a maximum temperature of 53 degrees F dew point.

Maximum outside air damper D1B and maximum spill air damper D11B remain closed. Minimum outside air damper D1A, minimum spill air damper D11A, and return air damper D10 remain open. Preheat coil steam control valves V3 remain under the control of their sensors TS3/preheat coil controller combinations.

Winter Cycle. To set the HVAC unit into winter operation, the Auto/Winter/Summer switch in the RFP must be set to the WINT position. See Figure 4.37. Temperature sensor TS8, in the north supply duct, in conjunction with its reheat controller and sensor T8 in the west supply duct, in conjunction with its unit transducer, control, in sequence, their respective reheat coil steam control valve V8, variable outside air damper D1B, variable spill air damper D11B, return air damper D10, and chilled water control valve V4, to maintain an adjustable room air temperature. Additionally, sensor T9, on the north wall of the lobby, in conjunction with its unit transducer in the RFP, resets the set point of the temperature sensor TS7/discharge controller combination in HVAC unit ACS 7-13. See Figure 4.39.

On a rise in temperature above the setting of the temperature sensor TS8/reheat controller combination or the sensor T8/unit transducer combination, control action is to gradually close their

respective reheat coil steam control valve V8, simultaneously open outside air damper D1B and spill air damper D11B; close return air damper D10 in a gradual action; and finally, gradually open chilled water control valve V4. In Tower A, the temperature sensor combination (TS8 in the north discharge duct, in conjunction with its reheat controller, or T8 in the west discharge duct, in conjunction with its unit transducer) calling for the most cooling controls the variable dampers and chilled water control valve V4. (In Tower B, sensor TS8 is in the west discharge duct and T8 is in the south discharge duct.)

On a rise in temperature above the setting of the north wall temperature sensor T9/unit transducer combination or the west wall sensor T9/unit transducer combination, control action is to first gradually close the north and west duct reheat coil steam control valves V8, then to simultaneously open maximum outside air damper D1B and maximum spill air damper D11B; close return air damper D10 in a gradual action; lower the set point of the temperature sensor TS7/discharge controller combination in HVAC unit ACS 7-13 (see Figure 4.39); and finally, gradually open chilled water control valve V4.

The wall sensor (T9 on the north wall or T9 on the west wall) unit transducer combination, calling for the most cooling, controls the resetting of the fan discharge temperature of HVAC unit ACS 7-13 and chilled water control valve V4 on unit ACS 7-11. See Figure 4.39.

Moreover, dew point sensor DPS7, downstream of the supply fan, in conjunction with the dew point controller and the SR in the LCP, can assume control of chilled water control valve V4 to maintain a maximum temperature of 53 degrees F dew point. Preheat coil steam control valves V3 remain under the control of their sensors TS3/preheat coil controllers.

Dew point sensor DPS7, in conjunction with the humidity controller in the LCP, also controls humidifier steam control valve V6 on the humidifier to maintain a scheduled dew point temperature of 32 degrees F to 49 degrees F, as the outside air temperature varies from 0 degrees to 50 degrees F. The sensor DPS7/humidity controller combination is reset by the Master Outside Air Reset Circuit, which is described in the latter part of this chapter.

Firestat. Firestat HT10, in the return air duct downstream of the return air fan, stops the return air fan and issues an alarm if the temperature of the return air exceeds 125 degrees F. See Figure 4.37.

Freezestat. Freezestat LT4, between the preheat coil and the cooling coil, stops the supply fan and energizes an alarm circuit if the air temperature between the preheat coil and the cooling coil drops below 35 degrees F.

Freeze Protection Pump. The freeze protection pump on HVAC unit ACS 7-11 and its control circuitry are similar to those of Peripheral HVAC unit ACS 7-2, and operate in a similar manner.

For a description of the operation of the unit ACS 7-11 freeze protection pump, refer back to the "Freeze Protection Pump" discussion for unit HVAC ACS 7-2 in the "Peripheral HVAC Units" section provided earlier in this chapter, but note that references to Figure 4.9 in that discussion change to Figure 4.37 for unit ACS 7-11.

Unit ACS 7-12, Tower A

HVAC unit ACS 7-12, Tower A, is similar to unit ACS 7-11, Tower A, and operates in a similar manner. For a description of the operation of unit ACS 7-12, refer back to the preceding description of operation for unit ACS 7-11, Tower A, but note that all references to north and west in the unit ACS 7-11 discussion change to south and east, respectively, when applying the discussion to unit ACS 7-12, Tower A.

Units ACS 7-11 And 7-12, Tower B

HVAC units ACS 7-11 and 7-12 in Tower B are similar to units ACS 7-11 and 7-12 in Tower A, and operate in a similar manner. For a description of the operation of HVAC units ACS 7-11 and 7-12, Tower B, refer to the description of operation for unit ACS 7-11, Tower A, provided earlier in this chapter, but note the change in compass directions for all air flows and ducts. See Note 2, Figure 4.37.

Unit ACS 7-13
Towers A and B

General. HVAC unit ACS 7-13 supplies conditioned air to the center (Core) of the lobby, as described earlier under the "General" heading of this Main Lobby HVAC section. Of the 4 lobby HVAC systems in each tower, unit ACS 7-13 is the only one that has only 1 discharge duct. Consequently, the unit has only 1 reheat coil. Moreover, the reheat coil is located upstream from the supply fan rather than downstream as in units ACS 7-11 and 7-12. See Figures 4.37 and 4.39. A left side view of HVAC unit ACS 7-13 is in Figure 4.40.

Operation. When supply fan ACS 7-13 is not operating, HVAC unit ACS 7-13 is in the following state (see Figure 4.39): outside air dampers D1A and D1B and spill air dampers D11A and D11B are closed; return air damper D10 is open; preheat coil steam control valves V3 may be open, closed, or partially open, depending on the outside air temperature; chilled water control valve V4, reheat coil steam control valve V5, and humidifier steam control valve V6 are all closed; return air fan ACR 7-12 is off; and, if the outside air temperature is above 34 degrees F, chilled water coil freeze protector valve VP4 is closed and freeze protection pump FP is off.

The steam supply to the preheat coils is monitored by preheat coil temperature sensors TS3, one on the downstream side of each coil section. (There are 4 coil sections in this unit.) These sensors, in conjunction with the preheat coil controllers in the

LCP, control normally-open preheat coil steam control valves V3, one on the inlet side of each preheat coil section. See Figures 4.3 and 4.6.

Operation of this circuit is as follows: when the temperature at sensors TS3 drops below 45 degrees F, the preheat coil controllers in the LCP decrease the control air pressure to preheat coil steam control valves V3, causing them to open proportionally and allow more steam to flow through the preheat coils.

The combinations of temperature sensors TS3 and their preheat coil controllers are reset by the Master Outside Air Reset Circuit. This eliminates the throttling range of the controller/sensor combinations so that a constant air temperature is maintained downstream of the preheat coils. (The Master Outside Air Reset Circuit is described in the latter part of this chapter.)

When return air fan ACR 7-12 is started, its interlock with supply fan ACS 7-13 is energized. Then, when the Start button for unit ACS 7-13 is depressed, the startup relay in the RFP is energized and Honeywell control air of 18 PSl is applied to minimum outside air damper motor M1A and spill air damper motor M11A. Dampers D1A and D11A start to open. (The RFP is in the same quadrant of the MER as unit ACS 7-13, adjacent to HVAC unit ACS 7-5.) When minimum outside air damper D1A has opened a preset amount, limit switch DS, operated by the damper closes, allows supply fan ACS 7-13 to start, and sets the entire control circuit in operation.

Summer Cycle. To set unit ACS 7-13 into summer operation, the Auto/Winter/Summer switch in the RFP must be set to the SUM position. See Figure 4.39. Temperature sensor TS7, in conjunction with the discharge controller in the LCP, controls, in sequence, reheat coil steam control valve V5 and chilled water control valve V4 to maintain an adjustable room air temperature. On a rise in temperature above the setting of the sensor TS7/discharge controller combination, control action is to gradually close reheat coil steam control valve V5, then to gradually open chilled water control valve V4.

The control point of the sensor TS7/discharge controller combination is reset by the sensor T9/unit transducer combinations of HVAC units ACS 7-11 and 7-12. (See Figure 4.37 and refer to the operational description of unit ACS 7-11 provided earlier in this chapter.) The sensor T9/unit transducer combination in unit ACS 7-11 or ACS 7-12 calling for the most cooling, resets the control point of the TS7/discharge controller combination in unit ACS 7-13 up or down, to maintain the desired space temperature.

Dew point sensor DPS7, in conjunction with the dew point controller in the LCP, can override the control action of temperature sensor TS7 on chilled water control valve V4, to maintain a maximum dew point temperature of 53 degrees F.

Maximum outside air damper D1B and maximum spill air damper D11B remain closed. Minimum outside air damper D1A, minimum spill air damper D11A, and return air damper D10 remain open. Preheat coil steam control valves V3 remain under the control of their respective sensor TS3/preheat coil controller combinations.

<u>Winter Cycle</u>. To set the HVAC unit into winter operation, the Auto/Winter/Summer switch in the RFP must be set to the WINT position. See Figure 4.39. Temperature sensor TS7, in conjunction with the discharge controller and the dampers, cooling coil, and reheat coil proportional relays, controls, in sequence: reheat coil steam control valve V5 and chilled water control valve V4, to maintain an adjustable room air temperature. Maximum outside air damper D1B and spill air damper D11B remain closed, and return air damper D10 remains open.

On a rise in temperature above the setting of the sensor TS7/discharge controller combination, control action is to: gradually close reheat coil steam control valve V5; simultaneously open maximum outside air damper D1B and maximum spill air damper D11B; close return air damper D10 in a gradual action; and finally, gradually open chilled water control valve V4.

The control point of the sensor TS7/discharge controller combination is reset by the sensor T9/unit transducer combinations of HVAC units ACS 7-11 and 7-12. (See Figure 4.37 and refer to the operational description of unit ACS 7-11 provided earlier in this

chapter.) The sensor T9/unit transducer combination in unit ACS 7-11 or ACS 7-12, calling for the most cooling, resets the control point of the TS7/discharge controller combination in unit ACS 7-13 to maintain the desired space temperature.

Dew point sensor DPS7, in conjunction with the dew point controller in the LCP, can override the control action of the TS7/discharge controller combination on chilled water control valve V4, to maintain a maximum air temperature of 53 degrees F. Preheat coil steam control valves V3 remain under the control of their sensors TS3 and the preheat coil controllers in the LCP.

Dew point sensor DPS7, in conjunction with the humidity controller in the LCP, also controls humidifier steam control valve V6 on the humidifiers, to maintain a scheduled dew point temperature of 32 degrees F to 49 degrees F, as the outdoor air temperature varies from 0 to 50 degrees F. The sensor DPS7/humidity controller combination is reset by the Master Outside Air Reset Circuit, which is described in the latter part of this chapter.

Firestat. Firestat HT10, in the return air duct downstream from the return air fan, stops the fan and issues an alarm if the temperature of the return air exceeds 125 degrees F. See Figure 4.39.

Freezestat. Freezestat LT4, between the preheat coil and the cooling coil, stops the supply fan and energizes an alarm circuit if the temperature of the air between the preheat coil and the cooling coil drops below 35 degrees F.

Freeze Protection Pump. The freeze protection pump on HVAC unit ACS 7-13 and its control circuitry are similar to those of Peripheral HVAC unit ACS 7-2, and operate in a similar manner. For a description of the operation of the unit ACS 7-13 freeze protection pump refer back to the "Freeze Protection Pump" discussion for unit ACS 7-2 in the "Peripheral HVAC Units" section provided earlier in this chapter, but note that references to Figure 4.9 in that discussion change to Figure 4.39 for unit ACS 7-13.

Unit ACS 7-14

General. HVAC unit 7-14 has 3 discharge ducts and 3 individually controlled reheat coils. See Figure 4.41. In Tower A one duct discharges air to the west side of the lobby at the Concourse level. A second duct discharges downward from the Plaza level to the lobby core. The third duct discharges air downward from the Plaza level at all 4 perimeter walls.

In Tower B, one duct supplies conditioned air to the south side of the lobby at the Concourse level, and the other 2 ducts discharge air to the same areas of the lobby as they do in Tower A.

<u>Operation</u>. When supply fan ACS 7-14 is not operating, HVAC unit ACS 7-14 is in the following state (see Figure 4.41): outside air dampers D1A and D1B and spill air dampers D11A and D11B are closed; return air damper D10 is open; preheat coil steam control valve V3 may be open, closed or partially open, depending on the outside air temperature; chilled water control valve V4, humidifier steam control valve V6, and the 3 reheat coil steam control valves V8, are closed; return air fan ACR 7-13 is off; and if the outside air temperature is above 34 degrees F, chilled water coil freeze protector valve VP4 is closed, and freeze protection pump FP is off.

The steam supply to the preheat coils is monitored by preheat coil temperature sensors TS3, one on the downstream side of each coil section. (There are 6 coil sections in this unit.) These sensors, in conjunction with the preheat coil controllers in the LCP, control normally-open, preheat coil steam control valves V3, one on the inlet side of each preheat coil section. See Figures 4.3 and 4.6.

Operation of this circuit is as follows: when the temperature at sensors TS3 drops below 45 degrees F, the preheat coil controllers in the LCP decrease the control air pressure to preheat coil steam control valves V3, causing them to open and allow more steam to flow through the preheat coils.

The combinations of temperature sensors TS3 and their preheat coil controllers are reset by the Master Outside Air Reset Circuit. This eliminates the throttling range of the

controller/sensor combinations so that a constant air temperature is maintained downstream of the preheat coils. (The Master Outside Air Reset Circuit is discussed later in this chapter.)

When return air fan ACR 7-13 is started, its interlock with supply fan ACS 7-14 is energized. Then, when the Start button for the supply fan is depressed, the minimum damper relay in the RFP is energized. Honeywell control air of 18 PSI is applied to minimum outside air damper motor M1A and spill air damper motor M11A, and dampers D1A and D11A start to open. (The RFP is in the same quadrant of the MER as unit ACS 7-14, near HVAC unit ACS 7-2.) When minimum outside air damper D1A has opened a preset amount, limit switch DS, operated by the damper, closes and allows supply fan ACS 7-14 to start, and the entire control circuit is set in operation.

Summer Cycle. To set unit ACS 7-14 into summer operation, the Auto/Winter/Summer switch in the RFP must be set to the SUM position. See Figure 4.41. Temperature sensors T8, one in each discharge duct, in conjunction with their unit transducers control, in sequence, their respective reheat coil steam control valve V8 and chilled water control valve V4, to maintain an adjustable room air temperature. Each temperature sensor T8/unit transducer combination is reset by its respective wall sensor T9/unit transducer combination.

On a rise in temperature above the setting of a temperature sensor T8/unit transducer combination, control action is to gradually close its respective reheat coil steam control valve V8 and open chilled water control valve V4. The sensor T8/unit transducer combination calling for the most cooling controls chilled water control valve V4.

Dew point sensor DPS7, in the common discharge duct, in conjunction with the dew point controller in the LCP, can assume control of chilled water control valve V4 to maintain a maximum dew point temperature of 53 degrees F. Maximum outside air damper D1B and maximum spill air damper D11B remain closed. Return air damper D10 remains open. Preheat coil steam control valves V3 remain under the control of their respective sensor TS3/preheat controller combination.

Winter Cycle. To set the HVAC unit into winter operation, the Auto/Winter/Summer switch in the RFP must be set to the WINT position. See Figure 4.41. Temperature sensor T8, in each discharge duct, in conjunction with its unit transducer controls, in sequence: its respective reheat coil steam control valve V8; maximum outside air damper D1B; maximum spill air damper D11B; return air damper D10; and chilled water control valve V4, to maintain an adjustable room air temperature.

On a rise in temperature above the setting of any temperature sensor T8/unit transducer combination, control action is to: gradually close that sensor T8/unit transducer combination's

reheat coil steam control valve; simultaneously open maximum outside air damper D1B and maximum spill air damper D11B; close return air damper D10 in a gradual action; and finally, gradually open chilled water control valve V4. The sensor T8/unit transducer combination calling for the most cooling controls the chilled water control valve and the dampers.

Dew point sensor DPS7 and the preheat coil steam control valves V3 operate in the same manner as they do in the summer cycle. Dew point sensor DPS7, in conjunction with the humidity controller in the LCP, also controls humidifier steam control valve V6 on the humidifier to maintain a scheduled dew point temperature of 32 degrees F to 49 degrees F, as the outdoor air temperature varies from 0 to 50 degrees F. The sensor DPS7/humidity controller combination is reset by the Master Outside Air Reset Circuit, which is described later in this chapter.

Firestat. Firestat HT10, in the return air duct downstream from the return air fan, stops the fan and issues an alarm if the temperature of the return air exceeds 125 degrees F. See Figure 4.41.

Freezestat. Freezestat LT4, between the preheat coil and the cooling coil, stops the supply fan and energizes an alarm circuit if the air temperature between the preheat coil and the cooling coil drops below 35 degrees F.

Freeze Protection Pump. The freeze protection pump on unit ACS 7-14 and its control circuitry are similar to those of Peripheral HVAC unit ACS 7-2 and operate in a similar manner. For a description of the operation of the unit ACS 7-14 freeze protection pump, refer back to the "Freeze Protection Pump" discussion for unit ACS 7-2 in the "Peripheral HVAC Units" section provided earlier in this chapter, but note that references to Figure 4.9 in that discussion change to Figure 4.41 for unit ACS 7-14.

MASTER OUTSIDE AIR RESET CIRCUIT

General

As referred to earlier in this chapter in the descriptions of all the HVAC units, the temperature settings of the preheat coil temperature sensor/controller combinations and the dew point sensor/humidity controller combinations are reset by the Master Outside Air Reset Circuit. There is one of these circuits in each MER.

The circuit comprises a temperature sensor, a unit transducer, a pneumatic proportional relay, 2 pneumatic sequencing relays, and a positive relay. See Figure 4.42. The temperature sensor is mounted on an Aspirator Cabinet with the element of the sensor protruding into the cabinet. See Figures 4.43 and 4.44. The unit transducer and the pneumatic relays are in a compartment in an RFP in the MER.

The Aspirator Cabinet is on the fresh air intake wall, in the northeast corner of each MER. See Figure 4.45. In addition to the sensor, the cabinet also houses a fan and intake and exhaust openings. See Figure 4.44. The intake and exhaust openings extend through the eastern wall of the MER fresh air intake. See Figure 4.46.

Operation

An electrical signal from the outside air reset sensor, proportional to the outside air temperature, is connected to the unit transducer (X1) in the RFP. See Figure 4.42. The unit transducer converts the electrical signal to pneumatic.

The pneumatic signal, designated "9", is connected to all the preheat coil controllers in the LCPs of all the HVAC units in the MER. See Figures 4.9, 4.20, 4.22, 4.24, 4.28, 4.37, 4.39, and 4.41.

The 9 signal is also applied to the proportional relay and one sequencing relay in the RFP. See Figure 4.42. The output of the proportional relay becomes signal 9A. This signal is connected to all the humidity controllers of all the HVAC units in the MER that are equipped with humidifiers. See Figures 4.9, 4.20, 4.22, 4.24, 4.37, 4.39, and 4.41.

The output of the first sequencing relay is connected to the input of the second sequencing relay. The output of the second sequencing relay operates the positive relay. The output of the

positive relay signal is designated "6". See Figure 4.42. This signal is connected to terminal No. 1 of the freeze protection relays (FPRs) in the RFPs of all the HVAC units in the MER. See Figures 4.9, 4.20, 4.22, 4.24, 4.28, 4.37, 4.39, and 4.41. The FPR for each unit controls the operation of the chilled water coil freeze protection valve for that unit.

The operation of the chilled water coil freeze protection valve, in conjunction with the freeze protection pump, was described earlier in this chapter in the "Freeze Protection Pump" discussion for Peripheral HVAC unit ACS 7-2.

CHAPTER 5

INTERIOR REHEAT WATER SYSTEM

SCOPE

The Interior Reheat Water System heats and circulates the water which flows through the reheat coils that are in the supply ducts of the Interior air conditioning system. Note: For purposes of energy conservation the Interior Reheat Water System has been deactivated and all the reheat coils have been removed from the supply ducts. However, since the function of this manual is to document the HVAC System as it was originally designed and installed, this chapter is included in the manual.

Contained in the chapter are descriptions of the major components in the Interior reheat system. These include: a differential pressure bypass; the reheat water temperature control circuit; and a typical reheat coil temperature control circuit.

GENERAL

As described in Chapter 4, the Interior air conditioning system supplies conditioned air to the 4 Interior quadrants of all tenanted floors of the towers. When the conditioned air arrives at a floor it must travel through horizontal ducts from the vertical risers in the core of the tower to the Interior quadrants on the floor.

At the point where the horizontal ducts enter a quadrant, the conditioned air is reheated by a hot water reheat coil. The hot water flowing through the reheat coils is supplied by the Interior Reheat Water System. Moreover, the temperature of the water flowing through the reheat coils is automatically controlled. A detailed description of the operation of this temperature control circuit is in the latter part of this chapter, but the system that supplies the Interior reheat water to the reheat coils is described in the paragraphs that follow.

The Interior Reheat Water System in each tower actually comprises 6 individual heating and circulating systems. Each system comprises a converter (heat exchanger), 2 circulating pumps, a differential pressure bypass, the interior reheat coils on 15 or 16 floors, and associated piping.

The system and converter (HX) designations, the MERs they are in, and the floors they serve are listed in the table that follows. Moreover, since all 12 systems in both towers are similar and operate in a similar manner, for purposes of economy and to avoid unnecessary repetition in this manual, only the system that serves the 25th thru 40th floors in Tower A (System 41-5) is described here, and it is considered typical for all 12 systems in both towers.

Interior Reheat Water Systems
Towers A and B

System and HX No.	Location (MER)	Floors Served
7-3	7th Floor	9 thru 24
41-5	41st Floor	25 thru 40
41-6	41st Floor	43 thru 58
75-5	75th Floor	59 thru 74
75-6	75th Floor	77 thru 91
108-3	108th Floor	92 thru 106

The converter (HX) is a U-type device that consists of tubes in a shell. Water circulates through the tubes and is heated by steam that fills the shell. The converter is manufactured by the Yula Company of the Bronx, New York. The heated water is then pumped through the closed system, consisting of approximately 64 reheat coils and associated piping, by a circulating pump. See Figure 5.1. One pump is always on standby.

DIFFERENTIAL PRESSURE BYPASS

General

Included in the system is a differential pressure bypass. Controlling the flow of water through the bypass is a Honeywell pressure differential valve (differential bypass valve). This valve is controlled by a differential pressure controller. The differential bypass valve and controller are schematically represented in Figure 5.2.

The function of the differential pressure bypass is to compensate for the variations in demand (flow rate) of the reheat hot water and still maintain a fixed differential pressure between the interior supply (IRS) and the return (IRR). See Figures 5.1 and 5.2. The difference in flow rate between maximum demand and a lesser demand is diverted through the bypass.

The bypass piping is sized to handle a maximum of 80% of the system flow rate, and the design specification calls for a differential pressure of 25 PSI between the IRS and the IRR. A schematic of the differential bypass control circuit and the balance of the Interior reheat water control system is in Figure 5.2.

Operation

At maximum load the flow rate of the system is 360 GPM. At this flow rate and a differential pressure of 25 PSI, differential bypass valve V16 is closed and no water is being bypassed. See Figure 5.2. At any load less than maximum, valve V16 opens a proportionate amount and allows a portion of the maximum flow rate to be bypassed.

For example: assume that on a very cold morning in February all thermal sensors in the return air ducts of all 16 floors in the system are calling for maximum heat. Under this condition, the flow rate of the reheat system is 360 GPM. Differential bypass valve V16 is closed, and no water is being bypassed.

Now, assume that in the early afternoon the outside air temperature rises. Because of the increased temperature, the temperature sensors in the return air ducts, in conjunction with the transducers in the RFPs in the MERs, call for less reheat hot water. Let's assume that now the system only requires a flow rate of 200 GPM. This decrease in demand causes the pressure of the IRS to increase momentarily, thereby causing a momentary increase in the differential pressure sensed by reverse-acting differential pressure controller P16. See Figures 5.2 and 5.3.

The differential pressure controller then decreases the pressure of the control air to the diaphragm of differential bypass valve V16. See Figures 5.2 and 5.4. This causes V16 to open enough to bypass that quantity of water that brings the differential pressure between the IRS and the IRR back down to 25 PSI. The flow rate of the water flowing through the bypass will be the difference between the maximum flow rate of 360 GPM and 200 GPM, or 160 GPM.

Now assume that in the late afternoon, as the sun sets and the outside air temperature drops, the temperature sensors in the return air ducts call for more hot water in the reheat coils. Let's say that now the system requires a flow rate of 300 GPM. This increase in demand causes the pressure of the IRS to drop momentarily, thereby causing a decrease in the pressure differential sensed by differential pressure controller P16. The reverse-acting pressure controller then increases the pressure of the control air to differential bypass valve V16. This causes V16 to

close enough so that only 60 GPM flow through the bypass, and the pressure differential between the IRS and the IRR returns to 25 PSI.

EXPANSION TANK

Because of changing temperature and pressure, the water in the Interior Reheat Water Systems expands and contracts. For this reason, and to provide head, each Interior Reheat Water System is equipped with an expansion tank. See Figure 5.1.

The tank has a capacity of 210 gallons, is open to atmospheric pressure, and is located at least 2 floors above the highest floor served by the system. For example, the expansion tank for system 7-3, which serves Floors 9 thru 24, is on the 26th floor. The tank for system 41-5, which serves Floors 25 thru 40, is on the 43rd floor.

Except for dimensions, mountings, and capacities, the Interior reheat water expansion tanks, along with their associated piping and controls, are similar to the expansion tanks, piping, and controls of the Chilled Water System, which were discussed in Chapter 3 of this manual. Hence, for reasons of economy and to avoid repetition, the Interior reheat water expansion tanks are not described here.

For a photo of a typical expansion tank and its associated piping and controls, and a description of their operation, refer back to the expansion tanks section of Chapter 3; but note that the tanks for the Interior Reheat Water Systems are mounted

vertically, and that the water designations change from CHW and CHWR-H to IR and IRR, respectively, for the Interior reheat water.

REHEAT WATER TEMPERATURE CONTROL

General

The temperature of the water supplied to the 4 reheat coils on every tenant floor of the towers is regulated by a temperature control system. This system comprises: the converter, 2 normally closed automatic steam control valves, an immersion temperature sensor, a transducer, an alarm relay, a proportional relay, an EP relay, and an electric relay. See Figure 5.2.

The Interior reheat water is heated in the converter by the LPS, and the quantity of steam flowing into the converter is regulated by the 2 automatic steam control valves. A description of the operation of the control system is in the following paragraphs.

Operation

When circulating pumps P41-9 and P41-10 (see Figure 5.5) are not operating, steam control valves V13A and V13B are closed. See Figure 5.2. When either pump is started (one pump is always on standby), the control system is set in operation.

Immersion temperature sensor T15S, in the heated water supply main (IRS), in conjunction with the transducer and the proportional relay in the LCP, regulates steam control valves V13A and

V13B in the steam supply to converter HX 41-5. See Figures 5.2 and 5.6. When the temperature of the IRS falls below the temperature set on the transducer, the transducer, in conjunction with the proportional relay, increases the control air pressure to normally closed stream control valves V13A and V13B. At first V13A opens proportionally and allows more steam into the shell of the converter, but when larger quantities of steam are required, V13B opens. The increaseed volume of steam in the converter raises the temperature of the IRS to the temperature set on the transducer.

Upon an increase in the IRS temperature above that set on the transducer, the control circuit operates in a reverse manner and lowers the temperature of the IRS. In this manner, the IRS is maintained at the temperature set on the transducer.

REHEAT COIL CONTROL

General

Each of the 4 reheat coils on every tenant floor (see Figure 5.7) of the towers is supplied with Interior reheat water. The volume of reheat water flowing through each reheat coil is regulated by an automatic control valve (V8) in the IRR pipe from that coil. See Figure 5.7. The control valve is regulated by a sensor-transducer control system that provides for local control of each reheat coil. See Figure 5.8.

Since all reheat coil control circuits are similar and operate in a similar manner, for reasons of economy and to avoid repetition, only the operation of the reheat coil for the northwest quadrant of the 25th floor is described here, and the description is considered typical for all reheat coils in both towers.

Operation

The control system for the reheat coil is shown in Figure 5.8. When supply fan ACS 41-5 in the 41st floor MER is not operating, the control valve (V8) on this reheat coil and the 63 others supplied with conditioned air by HVAC unit ACS 41-5 are closed. When supply fan ACS 41-5 is started, the control systems for all 63 reheat coils are set into operation.

At all times that the system is in operation, normally-closed control valve V8 is regulated by temperature sensor T8, in conjunction with its associated transducer located in the RFP in the northwest quadrant of the 41st floor MER. See Figure 5.8. The sensor T8/transducer combination is reset by temperature sensor T10 in the return air duct.

Operation of the control system is as follows: upon a drop in supply air temperature below that set on the transducer, the transducer increases control air pressure to the diaphragm of control valve V8, causing it to open proportionally. This increases the volume of the reheat water flowing through the reheat coil, thereby raising the temperature of the Interior supply air moving

through the reheat coil until the temperature of the supply air rises to the temperature set on the transducer.

Upon an increase of the supply air temperature above that set on the transducer, the transducer decreases the control air pressure to control valve V8. This causes the valve to close proportionally and decrease the volume of reheat water flowing through the coil. This decreases the temperature of the supply air to that preset on the transducer.

CHAPTER 6

SECONDARY WATER AND PERIPHERAL AIR CONDITIONING SYSTEMS

SCOPE

The Secondary Water System that supplies heated or chilled water to the Induction units of the Peripheral Air Conditioning System in the towers is the subject of this chapter. Included in the chapter are: tables listing the areas served by each subsystem; and descriptions of the operation of the control system, the differential/pressure bypass, and the Induction units on the tenant floors.

GENERAL

The Secondary Water System supplies heated or chilled water to the peripheral air conditioning Induction units on every tenant floor in the towers, as described in Chapter 1. The heated water is used during the winter heating season and the chilled water is used during the summer cooling season.

The Secondary Water System in each tower actually comprises 12 individual, totally-closed, independent subsystems.

Each subsystem consists of a converter (heat exchanger), a cooler, 2 circulating pumps, a differential pressure bypass, piping, and Induction units. See Figure 6.1. (The Induction units are described later in this chapter.) In each subsystem the water is either heated by the converter or cooled by the cooler, and pumped up or down 15 or 16 stories by one circulating pump. (One pump is always on standby.)

The coolers, converters, and circulating pumps are in the MERs. A photo of a typical converter/cooler combination is in Figure 6.2. A schematic of a typical converter/cooler combination, along with its control valves and piping connections, is in Figure 6.3.

Typical circulating pumps can be seen in Figure 6.4. Cooler and converter designations, the MERs they are in, and the zones they serve are listed in Table 6.1, which follows.

Table 6.1

Coolers and Converters
Secondary Water System

Towers A and B

Cooler(SC) or Converter(HX) Designation	Location (MER)	Zones Served
7-1	7th Floor	North and West, Floors 9 thru 24
7-2	" "	South and East, Floors 9 thru 24
41-1	41st Floor	North and West, Floors 25 thru 40
41-2	" "	South and East, Floors 25 thru 40
41-3	" "	North and West, Floors 43 thru 58
41-4	" "	South and East, Floors 43 thru 58
75-1	75th Floor	North and West, FLoors 59 thru 74
75-2	" "	South and East, Floors 59 thru 74
75-3	" "	North and West, Floors 77 thru 91
75-4	" "	South and East, Floors 77 thru 91
108-1	108th Floor	North and West, Floors 92 thru 106
108-2	" "	South and East, Floors 92 thru 106

All 24 systems in both towers are similar and operate in a similar manner. Hence, for reasons of economy and to avoid repetition, only system No. 41-4, which serves the south and east zones of Floors 43 thru 58 of both towers, is described here, and the description is considered typical for all 24 systems.

HOT WATER SYSTEM

The converter (see Figures 6.2 and 6.3) is a U-type, steam-in-the-shell, water-in-the-tube-type device, manufactured by the Yula Co. of The Bronx, New York. The secondary water, flowing through the tubes of the converter, is heated by the steam in the shell of the converter, and pumped through the closed piping system by a circulating pump. The piping system consists of 16 stories of risers running along the insides of the peripheral walls of the tower, horizontal runs on Floors 41 and 58, and all the Induction units in the south and east zones of Floors 43 thru 58. See Figure 6.1. Note that only one pump is in operation at any one time. The second pump is always on standby.

COLD WATER SYSTEM

The cooler (see Figures 6.2 and 6.3) is a water-to-water heat exchanger, that utilizes primary chilled water from the Central Refrigeration Plant flowing through the shell of the cooler to cool the secondary water flowing through the tubes in the cooler. The water is then pumped through the closed piping system and the Induction units by a circulating pump, in the same manner as in the hot water system described in the previous paragraph.

DIFFERENTIAL PRESSURE BYPASS

General

Included in each closed Secondary Water System is a differential pressure bypass. See Figure 6.5. Controlling the flow of water through the bypass piping is a Honeywell, normally-open,

differential pressure control valve (differential bypass valve). See Figure 6.5. The function of the differential bypass is to compensate for changes in the flow rate of the secondary water, caused by varying air temperatures, and still maintain a constant pressure differential between the supply and return. The difference in flow rate between maximum system demand and a lesser demand is diverted through the bypass.

The differential pressure bypass piping is sized to handle a maximum of 80% of the system flow rate. The design specification for the bypass calls for a pressure differential of 25 PSI between the supply and return. A schematic of the bypass control system and the balance of the secondary water control system is in Figure 6.6.

Operation

At maximum demand the flow rate of the system is 1350 GPM. At this flow rate and a differential pressure of 25 PSI, differential bypass valve V15 is closed and no water is being bypassed. At any heating or cooling load less than maximum, the bypass valve opens proportionally and allows a portion of that maximum flow rate to be bypassed back to the return. See Figure 6.6

For example: assume that on a very cold morning in February, all automatic control valves on the Induction units in the south and east zones on the 43rd thru 58th floors are calling for maximum heat. The flow rate of the heated water in the system is 1350 GPM. Differential bypass valve V15 is closed and no water is

being bypassed. (Operation of the automatic control valves on the Induction units is described later in this chapter.)

Now, assume that in the early afternoon the outside air temperature rises. The automatic control valves on the Induction units call for less heated water. Let us say that the system requires a flow rate of only 1000 GPM. This decrease in demand causes the pressure of the South and East Zone Secondary Supply water (SESS) to increase momentarily, thereby causing an increase in the pressure differential sensed by reverse-acting differential pressure controller P15. See Figures 6.6 and 6.7.

The differential pressure controller then decreases the pressure of the control air to the diaphragm of differential bypass valve V15. This decrease in control air pressure allows V15 to open just enough to bypass the quantity of water required to bring the pressure differential between the SESS and the South and East Secondary Water Return (SESR) back down to 25 PSI. The flow rate of the water passing through the bypass will be 350 GPM.

Now assume that in the late afternoon the sun goes down and the outside air temperature drops. The automatic control valves in the Induction units call for more hot water. Let us say that now the system requires a flow rate of 1200 GPM. This increase in demand causes the pressure of the SESS to drop momentarily, thereby causing a decrease in the differential pressure sensed by differential pressure controller P15. P15 then increases the pressure of the control air to bypass valve V15. This increase in control air pressure causes V15 to close enough to allow only 150

GPM to flow through the bypass, and the differential pressure between the SESS and SESR returns to 25 PSI.

EXPANSION TANK

Because of changing temperature and pressure, the water in the Secondary Water Systems expands and contracts. For this reason, and to provide head, each Secondary Water System is equipped with an expansion tank. See Figure 6.1.

The tank has a capacity of 1100 gallons, is open to atmospheric pressure, and is located at least 2 floors above the highest floor served by the system. For example, the expansion tank for system 7-1, which serves the north and west zones on Floors 9 thru 24, is on the 26th floor. The tank for system 41-2, which serves the south and east zones on Floors 25 thru 40, is on the 43rd floor.

Except for dimensions and capacities, the secondary water expansion tanks, along with their associated piping and controls, are similar to the tanks, piping, and controls of the Chilled Water System. Hence, for reasons of economy and to avoid repetition, the secondary water expansion tanks are not shown here and their operation is not described.

For a photo of a typical expansion tank and its associated piping and controls, see Figure 3.6 in this manual, but note that the tanks for the Secondary Water Systems are vertical rather than horizontal. For a description of the operation of the expansion tank and its associated piping and controls, refer back to the

"Operation" discussion for the high-zone, chilled water expansion tank in Chapter 3 of this manual, but note the difference in tank capacities and water designations.

TEMPERATURE CONTROL SYSTEM

General

When pump P41-7 or P41-8 (either may be on standby) is not in operation, steam control valves V13A and V13B on converter HX 41-4 and chilled water control valve V14 on cooler SC 41-4 are in the closed position. See Figures 6.3 and 6.6. When either pump is started, the temperature control system is set in operation.

Changeover from winter to summer operation, and vice versa, is accomplished locally by means of a switch in the LCP, or remotely from the Honeywell central control panel (computer). See Figure 6.6. Additionally, during winter operation, there are 2 temperature settings: Day and Night. Selection of either of these settings is also accomplished locally by means of a switch in the LCP, or remotely from the central control panel. See Figure 6.6.

Summer Cycle

General. With the Winter/Summer/Auto switch in the LCP set to the SUM position, summer immersion temperature sensor T15S, in conjunction with the summer transducer in the LCP, regulates chilled water control valve V14 on cooler SC 41-4, to maintain a leaving water temperature of 50 degrees F. Manual control of this temperature setting is provided by a control on the summer

transducer in the LCP. Steam control valves V13A and V13B on heat exchanger HX 41-4 remain in the closed position.

Operation. As the automatic control valves on the Induction units on each floor call for more or less chilled water, the temperature of the chilled water varies in accordance with the principle of heat exchange. This variation in temperature is sensed by summer temperature sensor T15S and transmitted to the summer transducer in the LCP. See Figure 6.6.

If the temperature of the secondary water rises above the temperature set on the summer transducer, the transducer increases the pressure of the control air to chilled water control valve V14 on the cooler. This causes V14 to open a proportional amount and allow a greater volume of chilled water into the shell of the cooler, thereby lowering the temperature of the secondary water flowing through the tubes in the cooler.

When the temperature sensed by T15S drops below the setting on the summer transducer, the transducer decreases the control air pressure to valve V14; the valve closes a proportional amount and decreases the quantity of chilled water supplied to the cooler. This causes the temperature of the secondary water to rise to the temperature set on the transducer.

Winter Cycle

General. Two winter immersion temperature sensors (T15D and T15N), in conjunction with their respective transducers, which are located in the LCP, control steam control valves V13A and V13B in

the steam supply to the hot water converter. See Figure 6.6. T15D, in conjunction with its transducer, becomes operational when the Day/Night/Auto switch is set to the Day position, and T15N, in conjunction with its transducer, operates when the Day/Night/Auto switch is set to the Night position.

The control points of both thermocouple-transducer combinations are automatically reset by a master outside air sensor, to produce a water temperature schedule. Chilled water control valve V14 on cooler SC 41-4 remains in the closed position.

Operation. With the Winter/Summer/Auto switch set to the Winter position and the Day/Night/Auto switch set to the Day position, operation of the control system is as follows: as the automatic control valves on the floor Induction units in the system call for more or less heated secondary water, the temperature of the secondary water varies in accordance with the principle of heat transfer.

This variation in temperature is sensed by winter/day immersion temperature sensor T15D, and transmitted to the winter/day transducer in the LCP. See Figure 6.6. If the temperature of the secondary water rises above the setting on the transducer, the transducer decreases the pressure of the control air to the diaphragm(s) of steam control valve(s) V13A and/or V13B. This decrease in air pressure causes V13A and/or V13B to close a proportional amount, and decrease the quantity of steam flowing into the shell of the converter; thereby reducing the temperature of the

secondary water flowing through the tubes in the converter and the system.

When the temperature of the secondary water drops below the setting on the transducer, the transducer increases the pressure of the control air on the diaphragm(s) of steam control valve(s) V13A and/or V13B. This causes the valve(s) to open a proportional amount and allow more steam into the shell of the converter; thereby causing the temperature of the secondary water to rise.

With the Day/Night/Auto switch set to the Night position, operation of the control circuit is similar to that for the Day position, except that winter/night temperature sensor T15N and the winter/night transducer become operational in place of T15D and the winter/day transducer. See Figure 6.6.

INDUCTION UNITS

General

The Induction units of the Peripheral air conditioning system (see Figures 6.8 and 6.9) are high-pressure, air/water, summer/winter, room air conditioning units that are connected to the Peripheral primary air ducts and the secondary water risers. Each Induction unit comprises an air plenum, primary air nozzles, a water coil assembly, a lint screen, a drain pan, an air transition fitting, and an air plug. See Figures 6.9 and 6.10.

High pressure primary air from the Peripheral HVAC units in the MERs is supplied to the plenum-nozzle combination in the Induction unit, and discharged thru the nozzles. See Figure 6.10.

The primary air induces the room air to flow across the coil through which the secondary water is flowing. Consequently, the induced air is either heated or cooled, depending upon the temperature of the secondary water flowing through the coil. The mixture of primary and induced air is discharged into the room via the output grilles on top of the unit. See Figure 6.8.

The function of the primary air is to provide ventilation and dehumidification to offset the latent loads of the area, and to be the motivating force for the induction and circulation of the room air. The function of the secondary water is to offset the heat gain or loss of the primary and induced air.

The Induction units are connected in parallel between the secondary water supply and return risers, in groups of 4, 5, 6, 9, and 10 called "Bays". See Figure 6.11. Each bay is equipped with 2 normally-open, automatic water control valves: one on the secondary water supply (SWS) and the other on the return (SWR).

The automatic water control valves are regulated by a pneumatic thermostat. The thermostat is a Honeywell, Model LP916B, proportional-type, 2-pipe controller with a remote, liquid-filled, bulb thermal element. The thermal element is installed in the return air path of one Induction unit in each bay. See Figure 6.11.

The thermostat is equipped with a built-in switchover mechanism that is used to change the thermostat from direct-acting to reverse-acting, via a change in main control air pressure. The thermostat is set for direct action to regulate heating by the

heated secondary water in the winter; and for reverse action to regulate cooling via the chilled secondary water in the summer. The main control air pressure for direct action is 18 PSI; and for reverse action 13 PSI.

Winter Operation

In the winter, when heated secondary water is flowing through the coils of the Induction units; a decrease in the temperature of the room air below the setting on the thermostat causes the thermostat to decrease control air pressure to the automatic water control valves. See Figure 6.11. This causes the valves to open a proportional amount and allow a greater volume of heated water to flow through the coils of the Induction units. This increased flow increases the temperature of the induced output air to the temperature set on the thermostat.

An increase in the temperature of the room air above the setting on the thermostat causes the thermostat to increase control air pressure to the automatic water control valves. This causes the valves to close a proportional amount and decrease the volume of heated secondary water flowing through the coils of the Induction units. This decreased flow of secondary water decreases the temperature of the induced output air down to the temperature set on the thermostat.

Summer Operation

In the summer, with cooled secondary water flowing through the coils of the Induction units (see Figure 6.11), an increase in the temperature of the room air above that set on the thermostat causes the thermostat to decrease the control air pressure to the automatic water control valves. This causes the valves to open a proportional amount and permit a greater volume of cool water to flow through the coils. This increased flow decreases the temperature of the induced output air to the temperature set on the thermostat.

A decrease in the temperature of the room air below that set on the thermostat causes the thermostat to increase the pressure of the control air to the automatic water control valves. This causes the valves to close a proportional amount and decrease the volume of chilled water flowing through the coils. This causes the temperature of the induced output air to rise until it reaches the setting on the thermostat.

CHAPTER 7

AIR DISTRIBUTION SYSTEMS

SCOPE

The manner in which conditioned air from the 3 types of HVAC units in the MERs (Core, Interior, and Peripheral), is distributed on each tenant floor of Towers A and B after the air leaves the vertical risers, is described in this chapter.

CORE AND INTERIOR AIR

As described earlier in Chapters 1 and 4, conditioned Core supply air for each floor is ducted from the vertical risers on: the east and west sides of tenant floors in Tower A; and the north and south sides of tenant floors in Tower B to certain light fixture/air diffusers in the ceilings of the Core areas. See Figure 7.1. Note that air from the Core areas does not return to the return air plenums in the MERs. The air is exhausted from the buildings via the toilet and local EMR exhausts.

Interior supply air is ducted from each of the 4 vertical risers (1 in each quadrant: northwest, northeast, southwest, and southeast) to certain light fixture/air diffusers in the Interior

of the floor. See Figure 7.1. Interior return air is drawn through other open, fluorescent light troffers into ceiling plenums. From these plenums the return air is drawn into the vertical return air shafts in the centers of the towers, to the return air plenums in the MERs.

PERIPHERAL AIR

Peripheral, primary air is ducted to every tenant floor in the towers via 4 vertical risers (1 in each quadrant). See Figure 7.2. From these risers the air is conveyed, via horizontal ducts, to the Induction units mounted along the bottoms of the window walls. See Figure 6.8. The horizontal ducts to the Induction units are run in the hung ceilings of the floors, directly below the Induction units they supply.

Figure

Figure

Figure

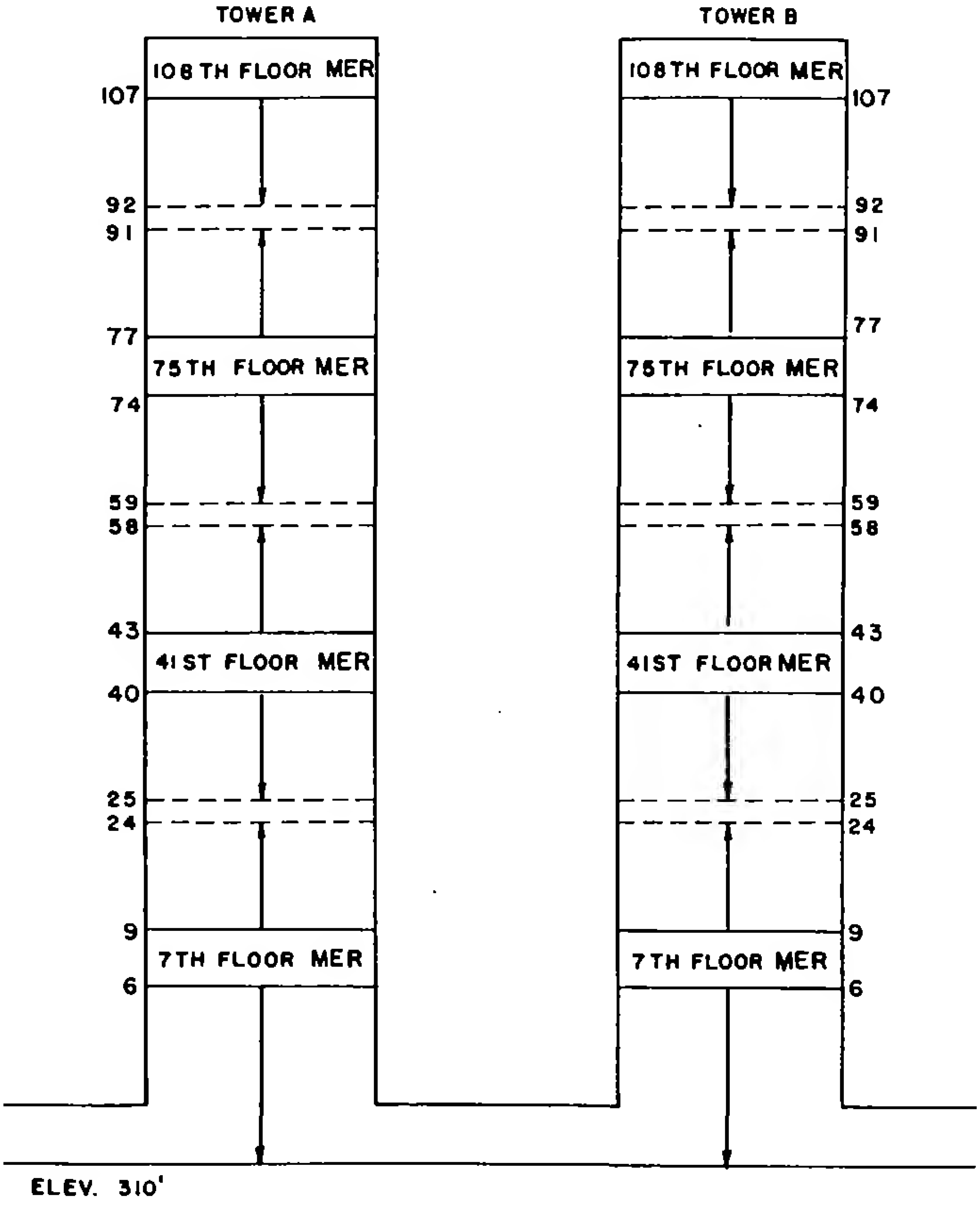


Figure 1.1 General Plan
Mechanical Equipment Room Service

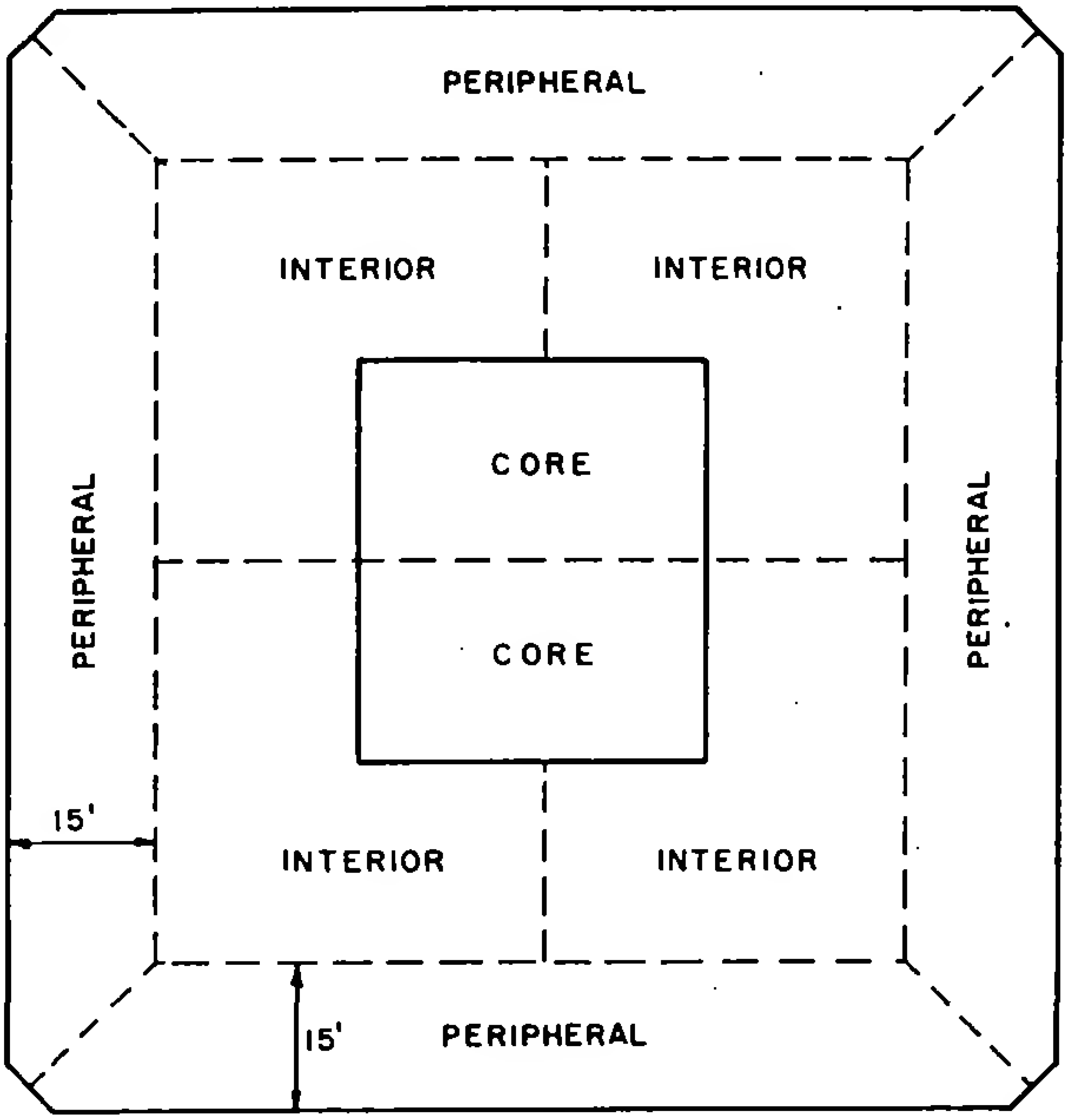


Figure 1.2 Plan – Air Conditioning Coverage Typical Floor

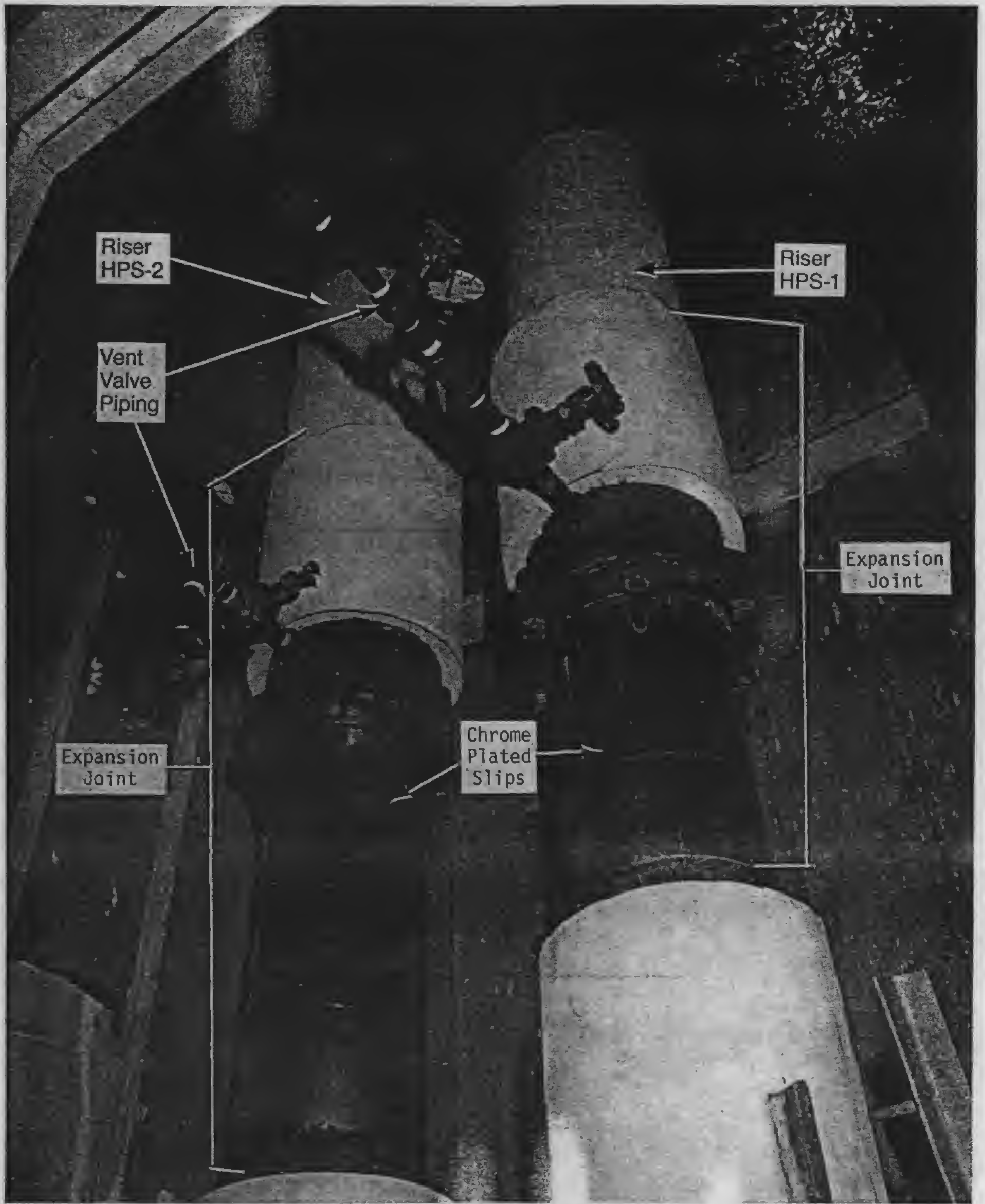


Figure 2.1 Typical Riser Expansion Joints
High Pressure Steam

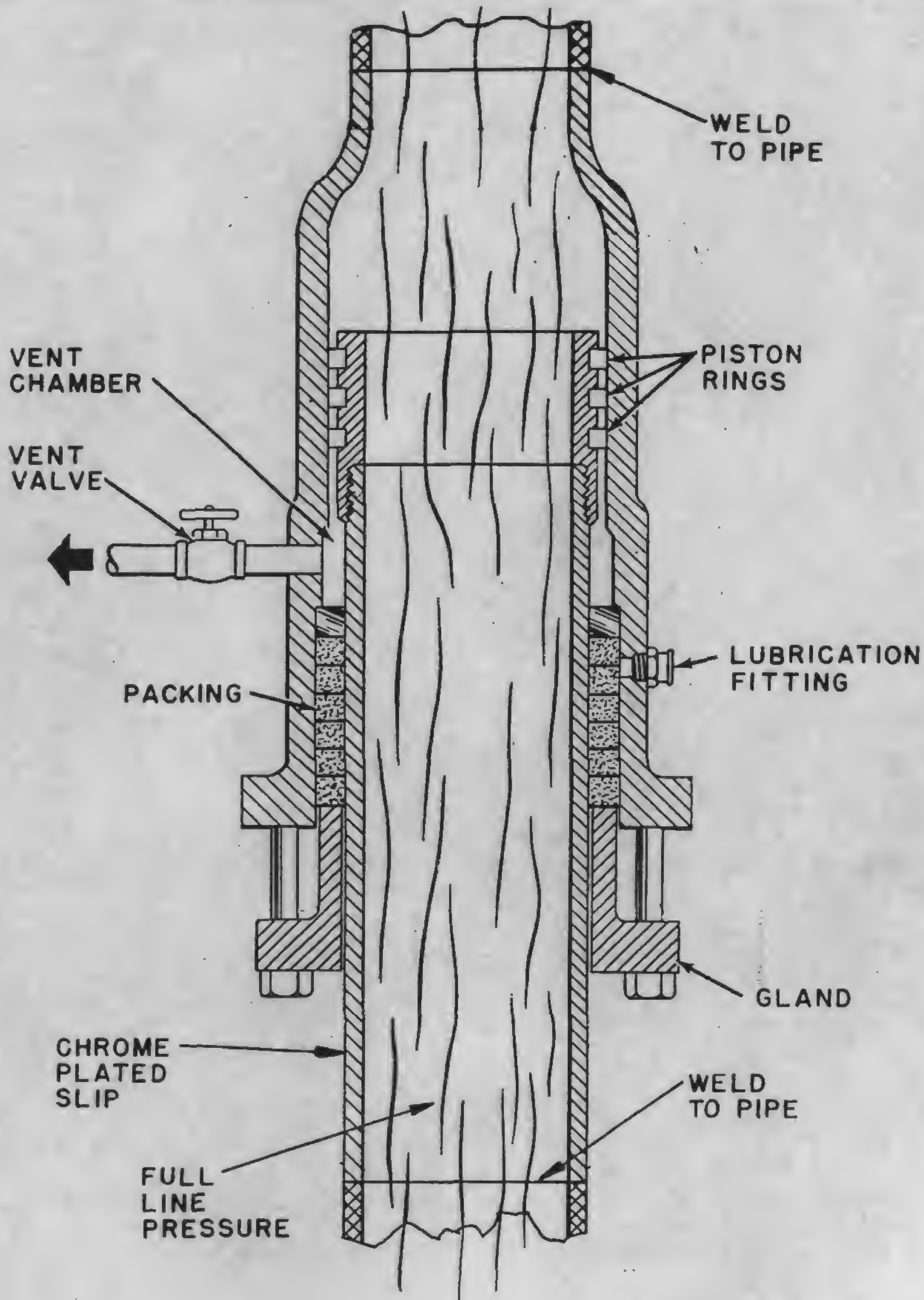


Figure 2.2 Sectional View
Piston Ring Expansion Joint

Figure 2.3 Main Steam Shutoff Valves
41st Floor MER

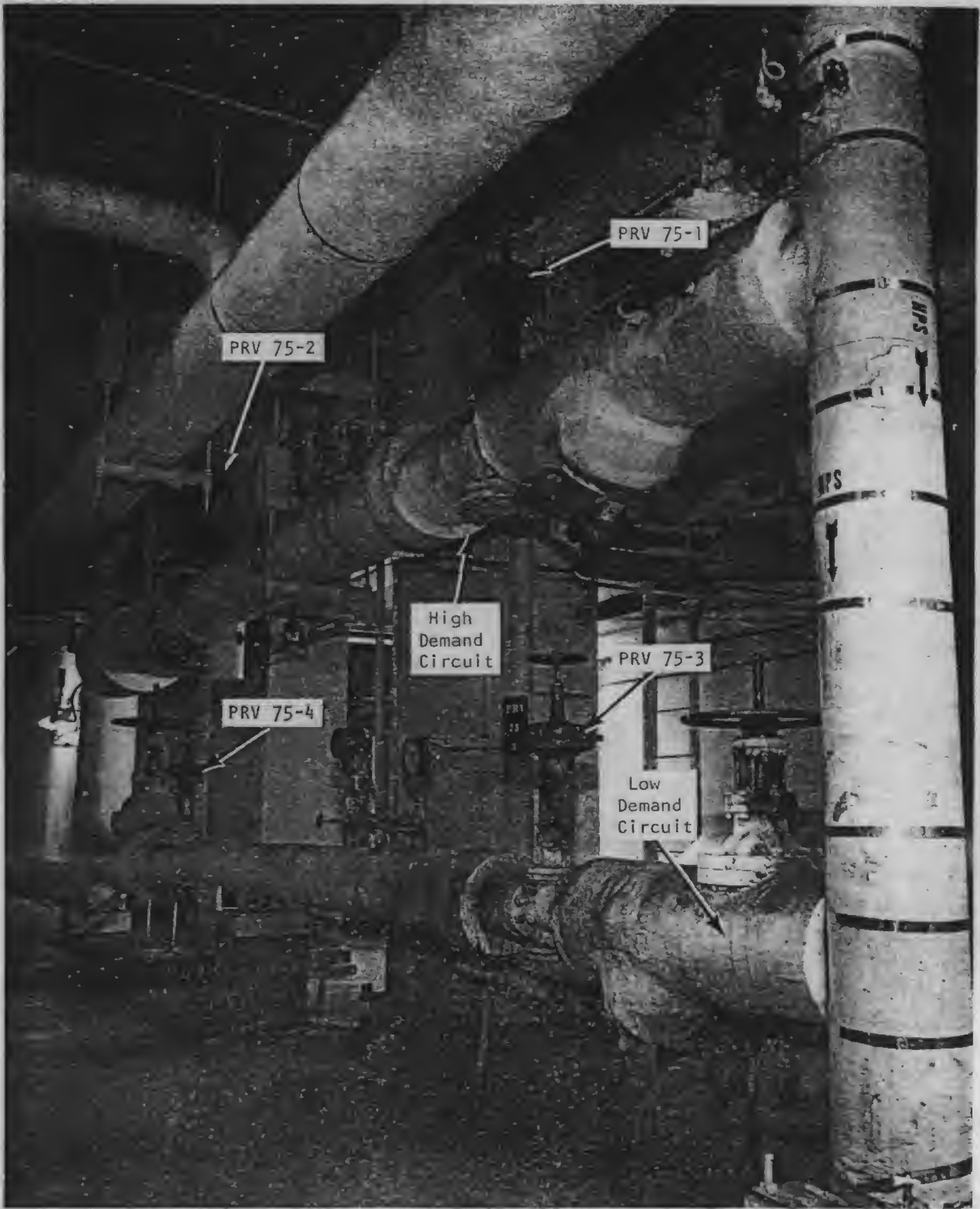


Figure 2.4 Pressure Reducing Station
75th Floor MER

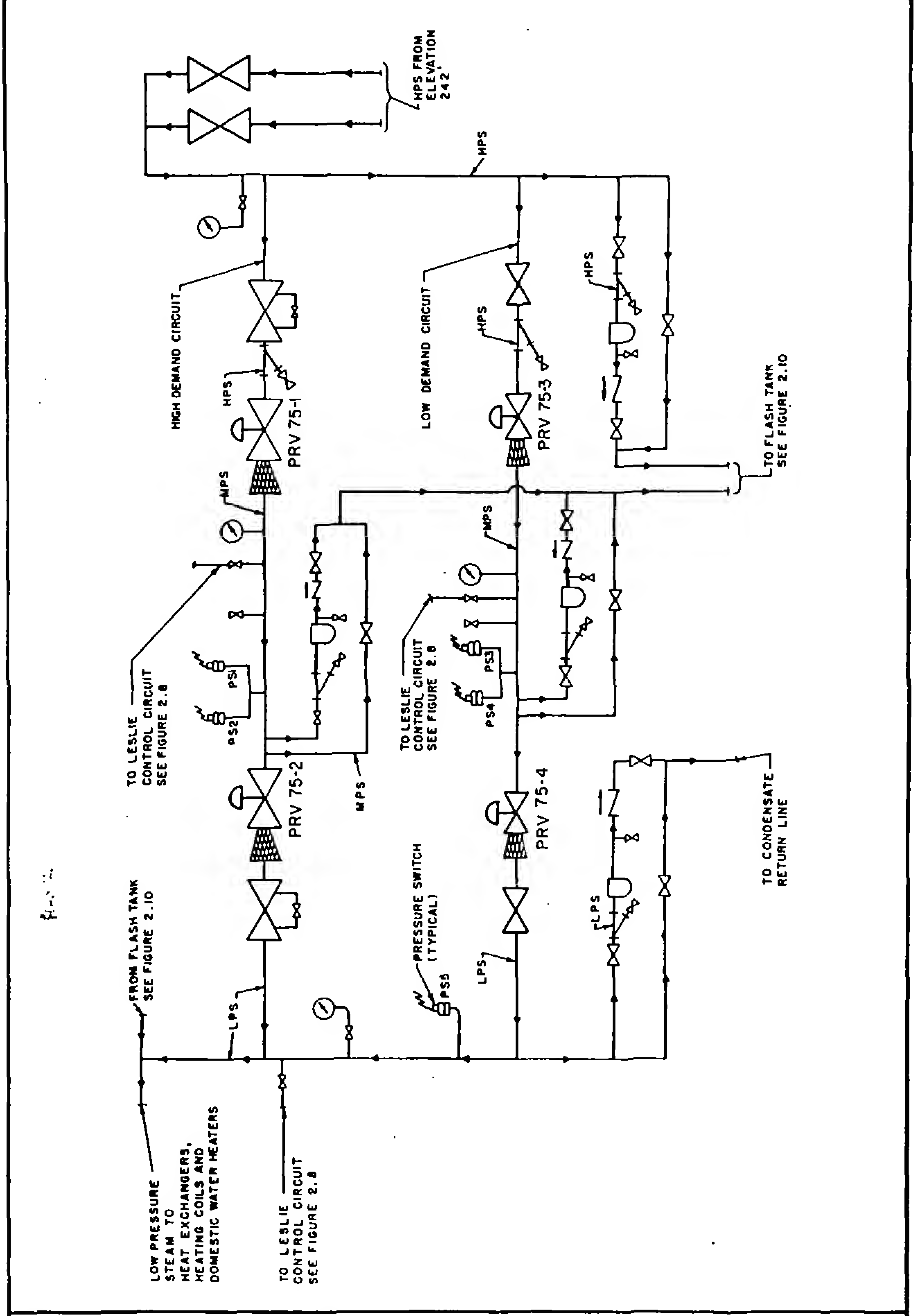


Figure 2.5 Schematic
Pressure Reducing Station—75th Floor MER

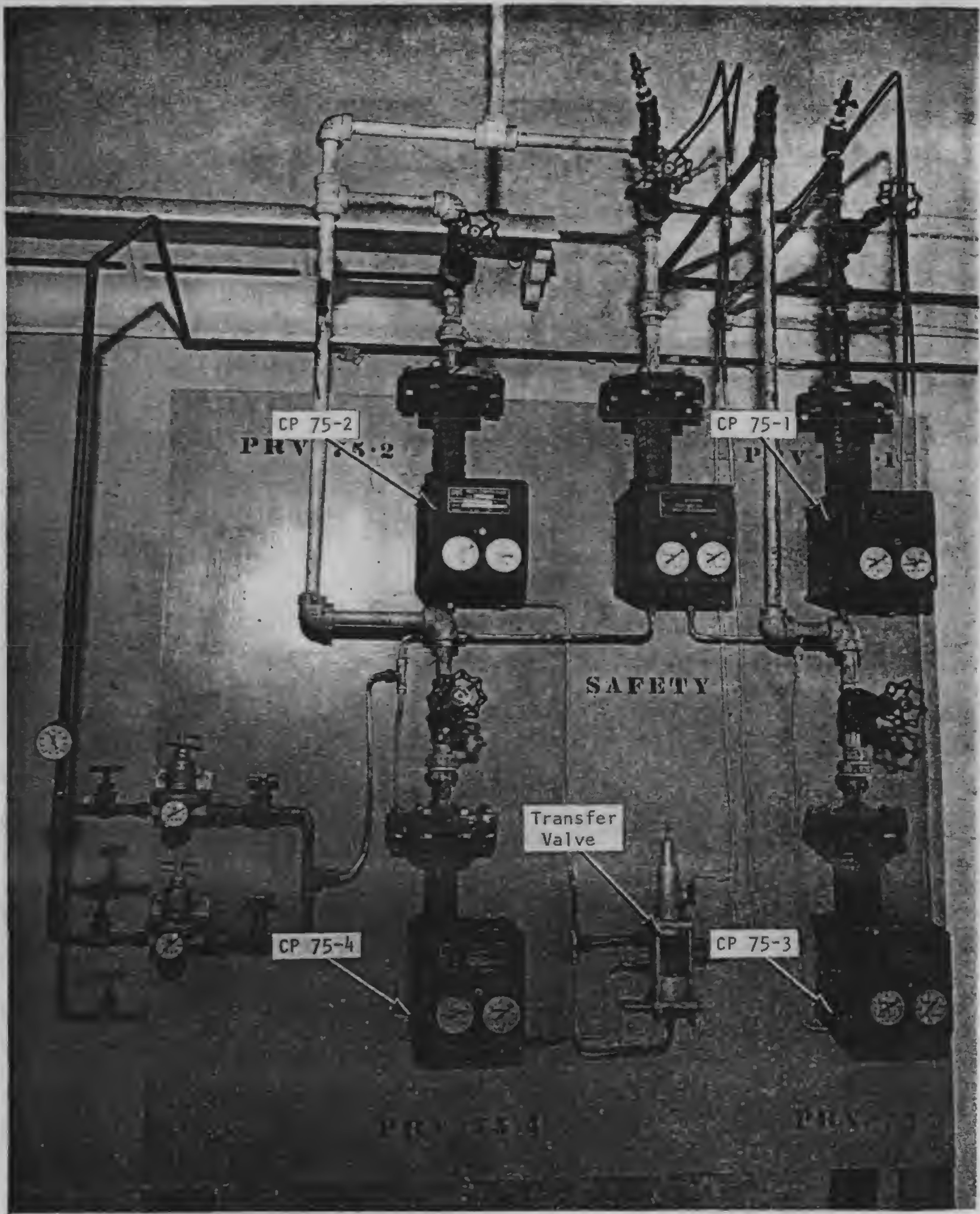


Figure 2.6 Pressure Reducing Control Panel
75th Floor MER

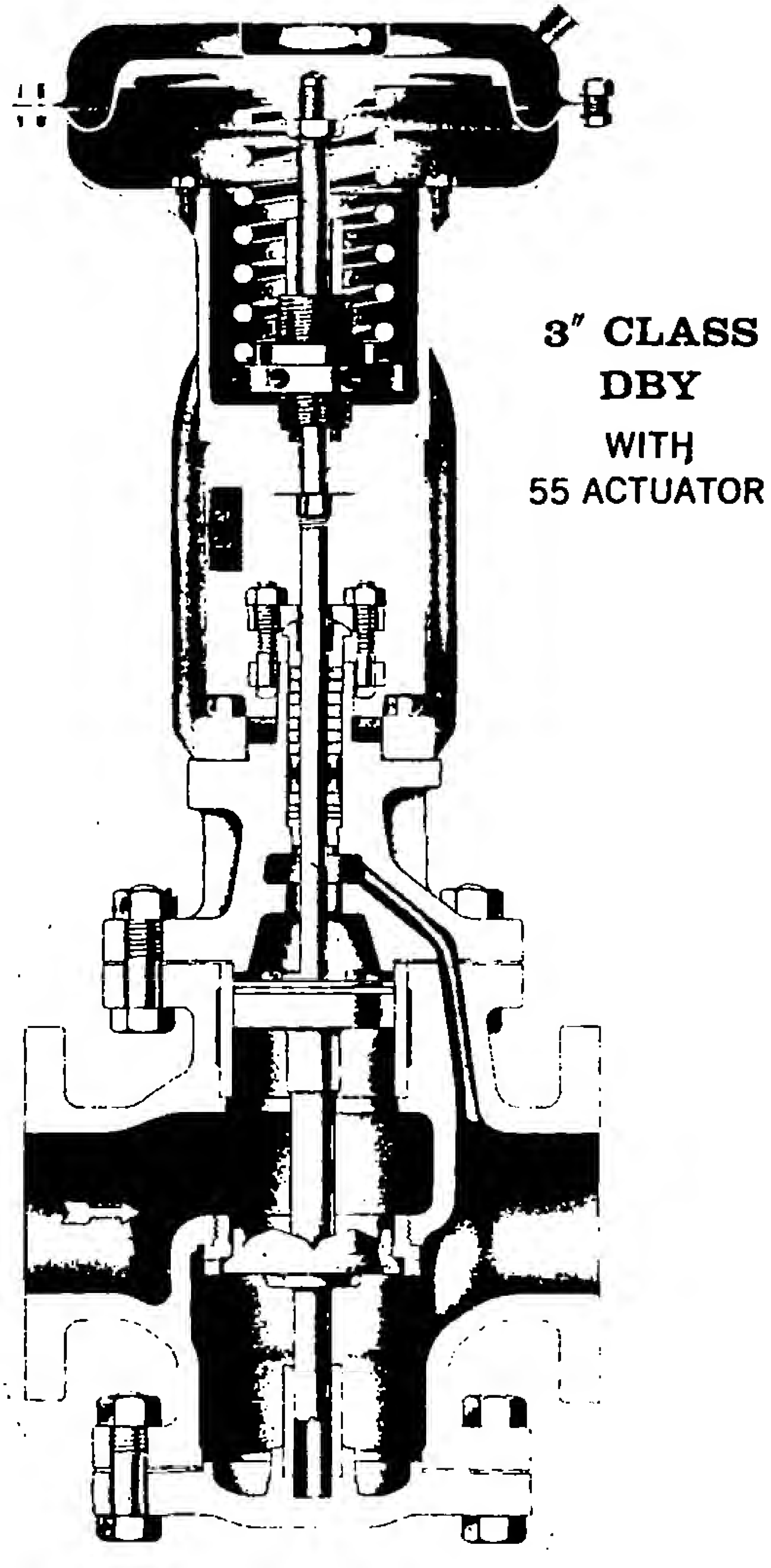


Figure 2.7 Cutaway View
Typical Pressure Reducing Valve

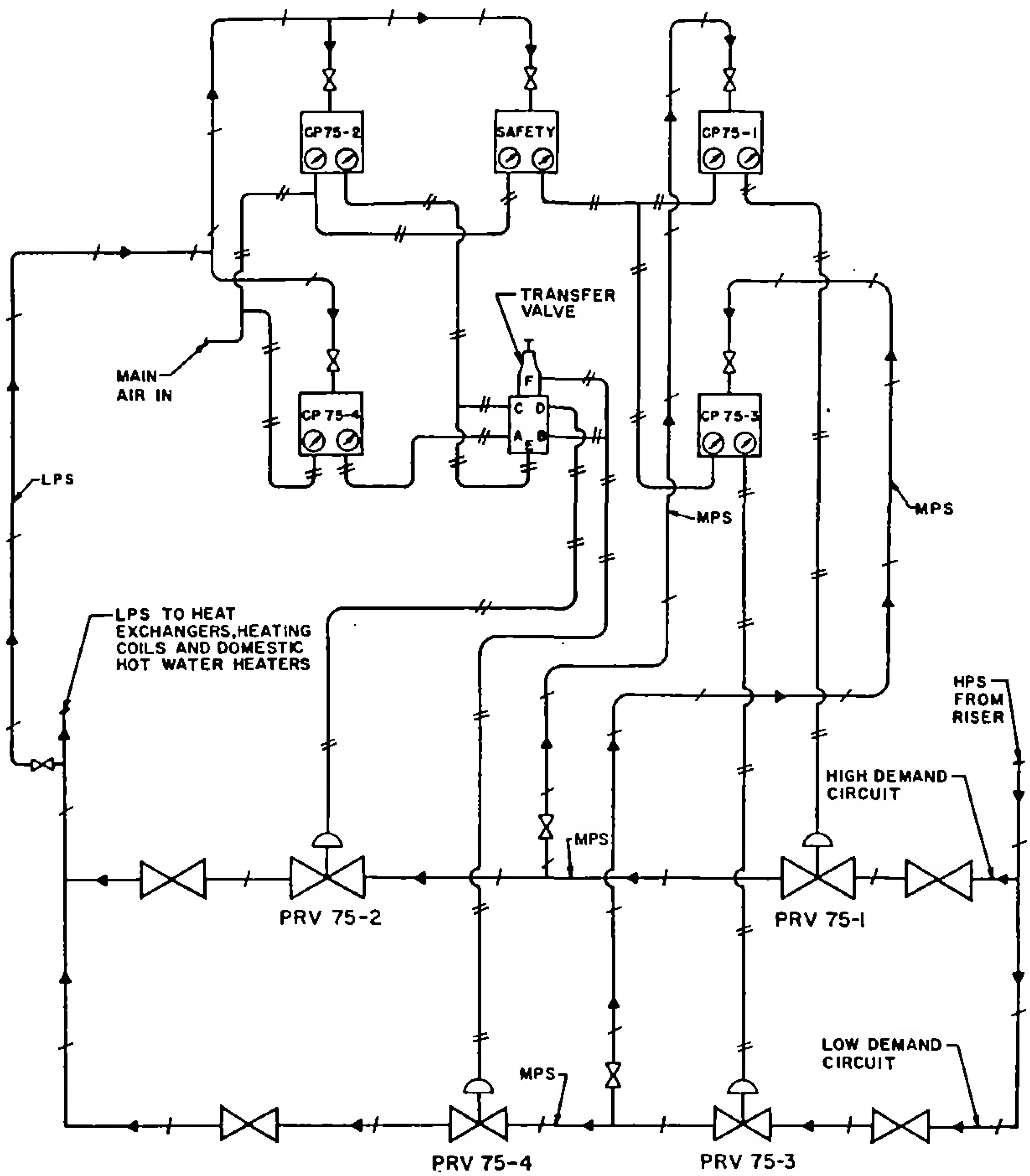


Figure 2.8 Control Diagram
Pressure Reducing Station — 75th Floor MER

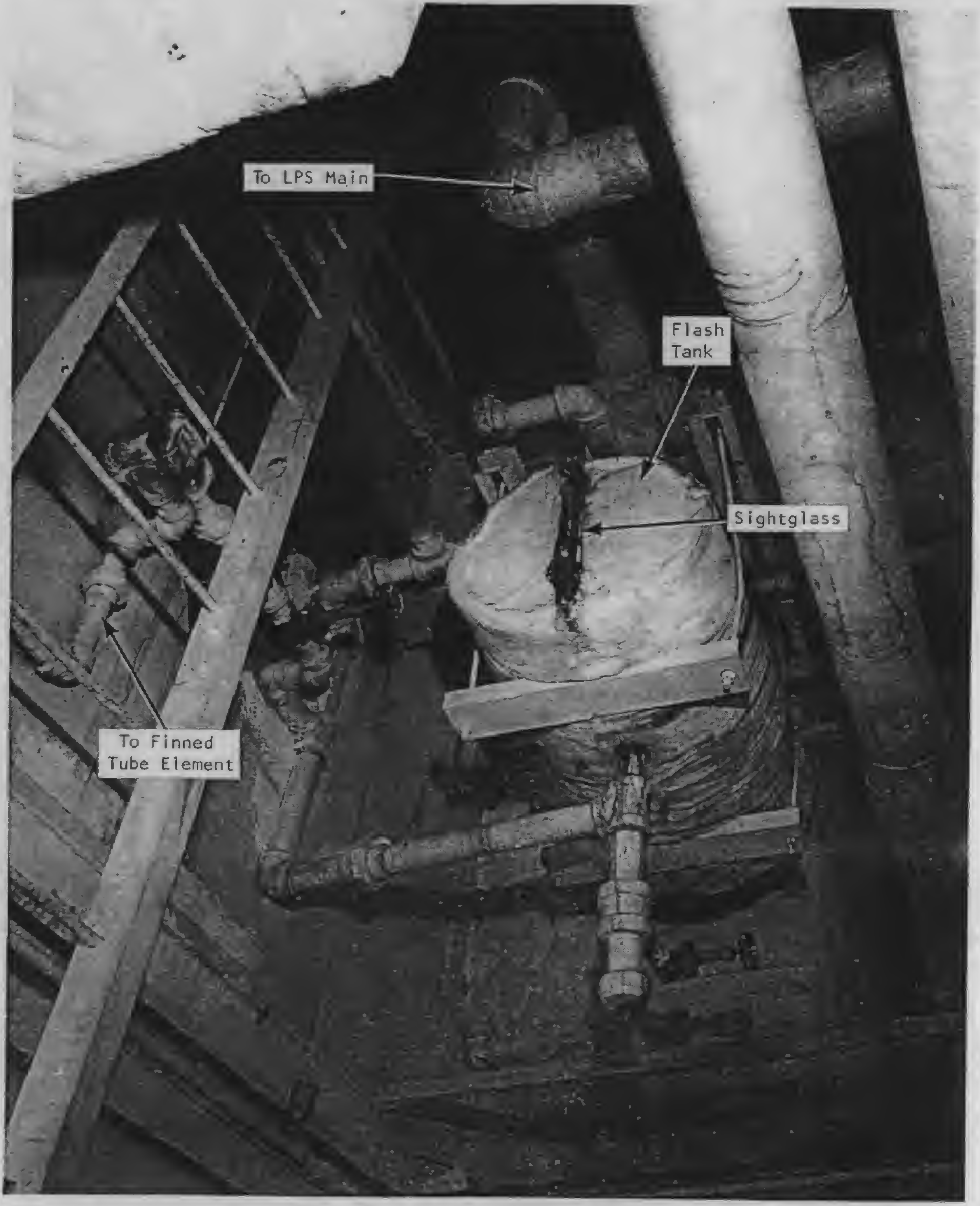


Figure 2.9 Flash Tank
75th Floor MER

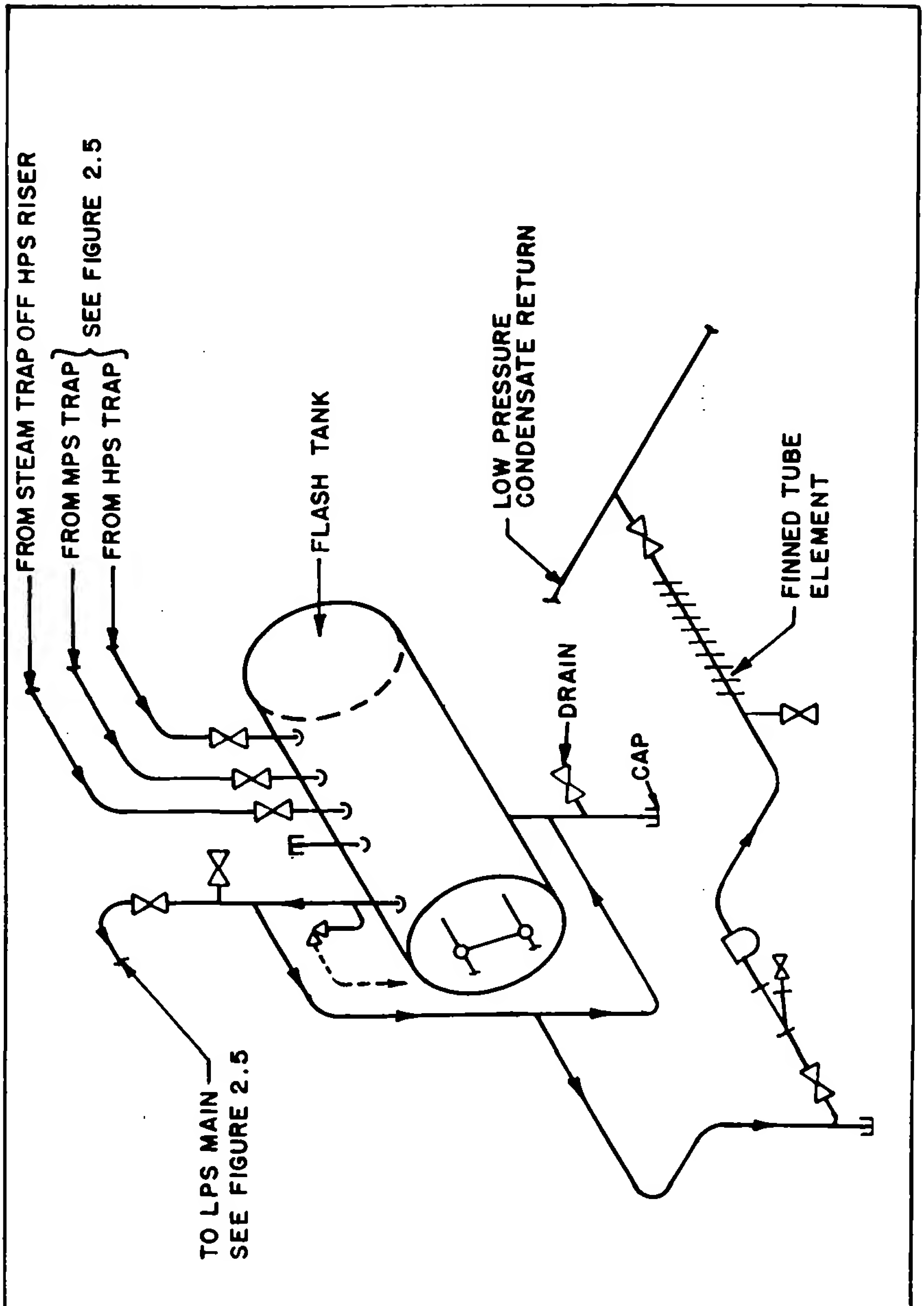


Figure 2.10 Schematic
Typical High Pressure Flash Tank Connections

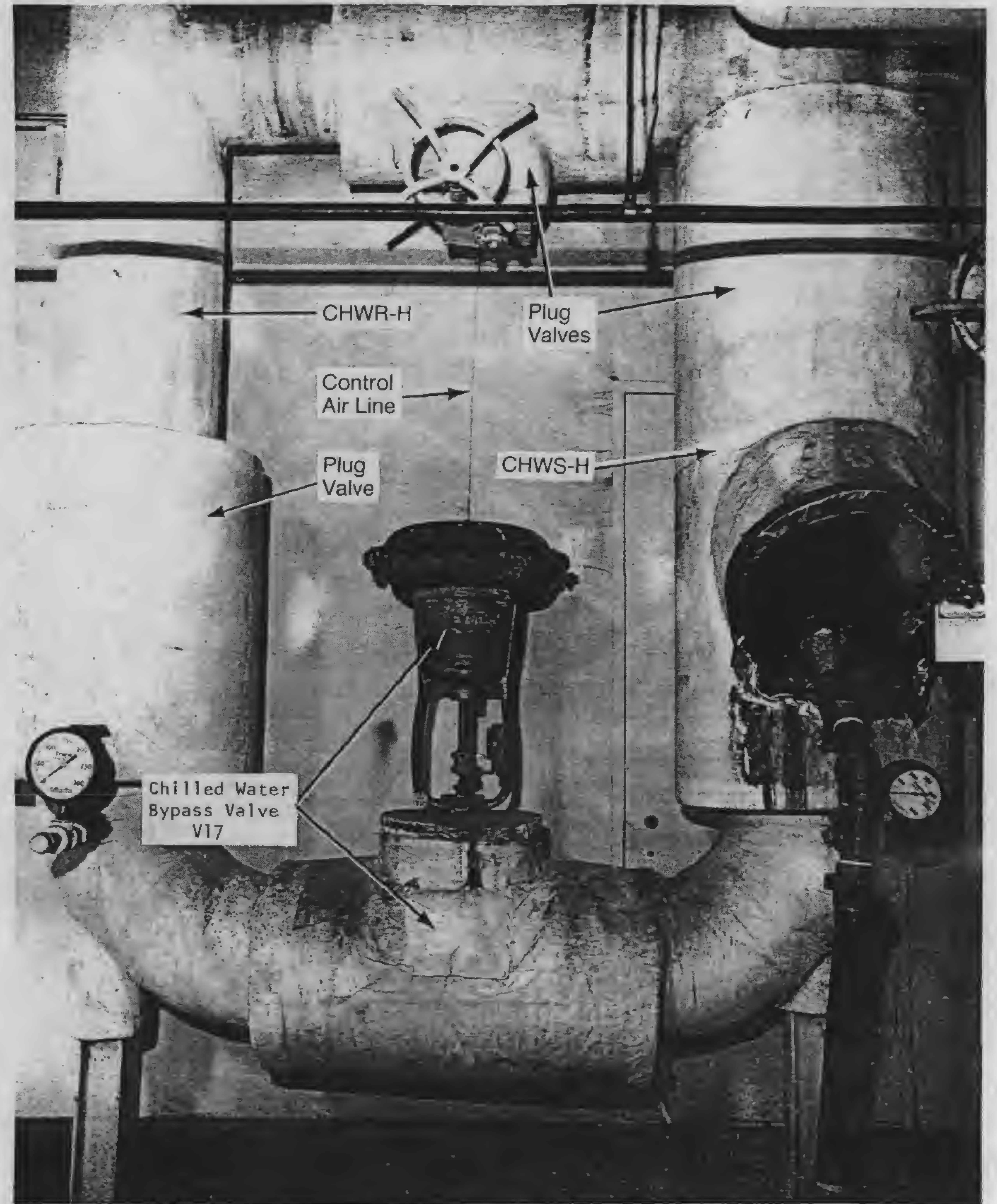


Figure 3.1 Differential Pressure Bypass
Chilled Water System - 75th Floor MER

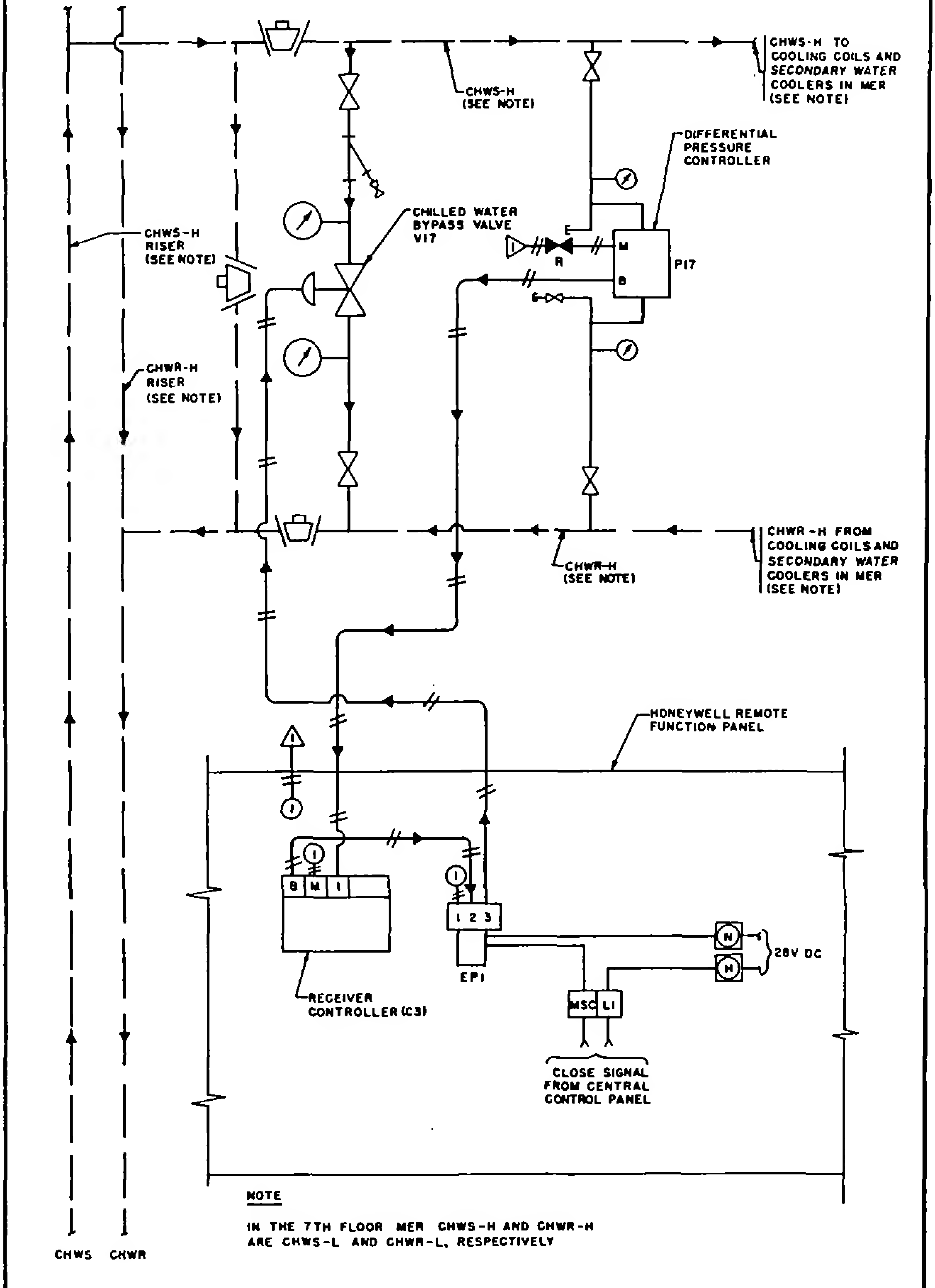


Figure 3.2 Control Diagram – Differential Bypass Chilled Water – 7th And 75th Floor MERs

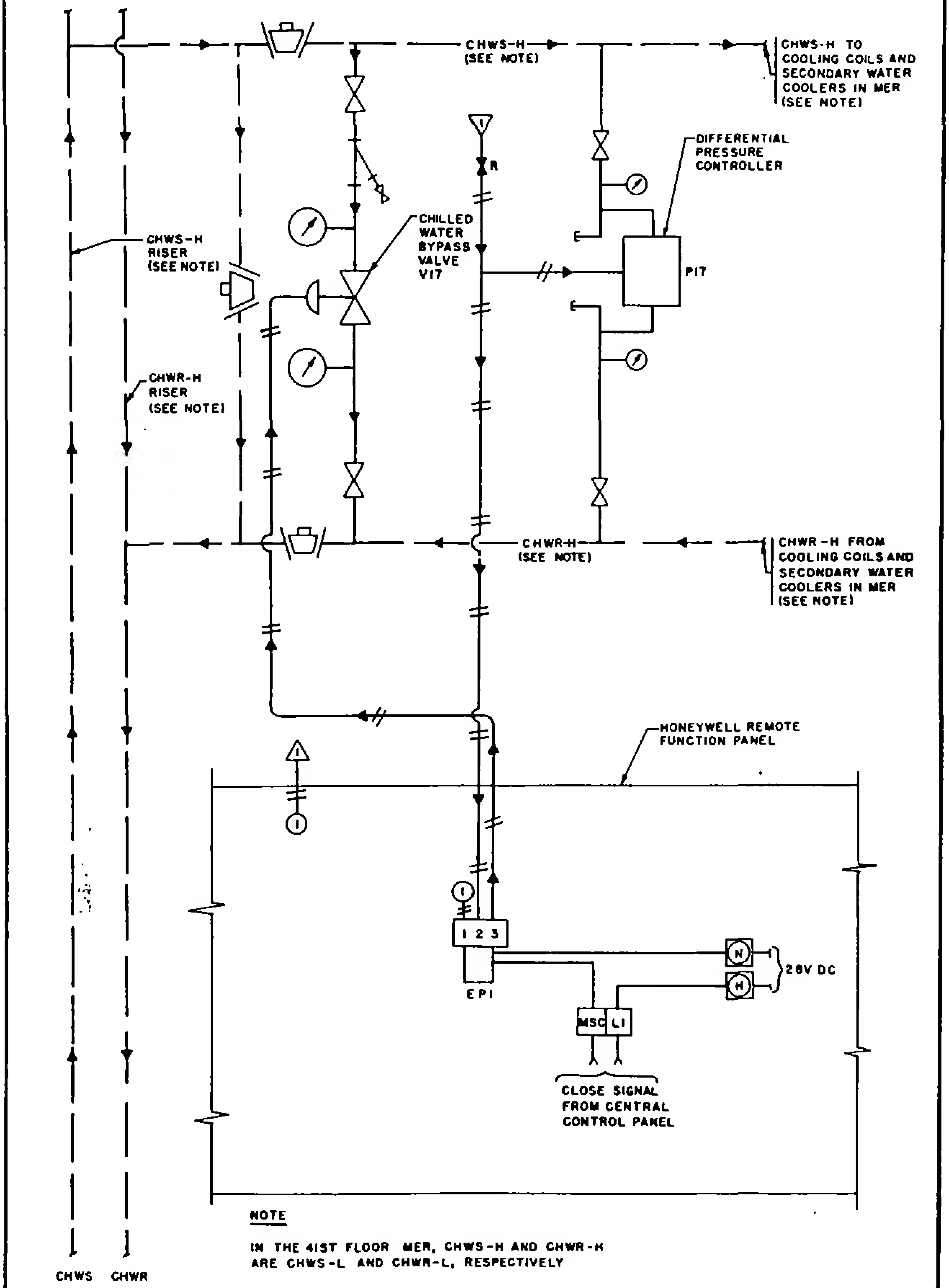


Figure 3.3 Control Diagram – Differential Bypass Chilled Water – 41st And 108th Floor MERs

Figure 3.3A Typical Differential Pressure Controller
7th And 75th Floor MERs

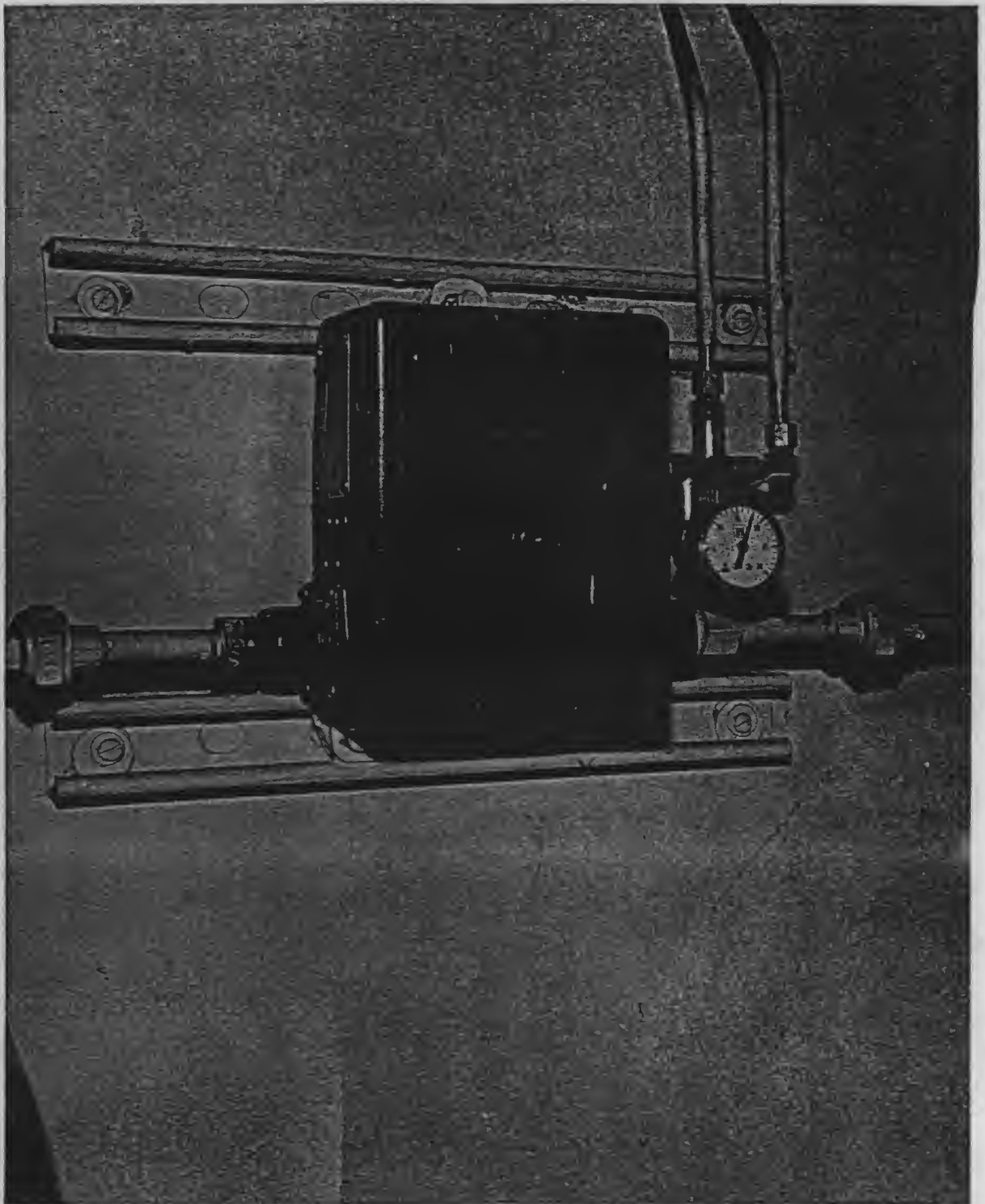


Figure 3.3B Typical Differential Pressure Controller
41st And 108th Floor MERs

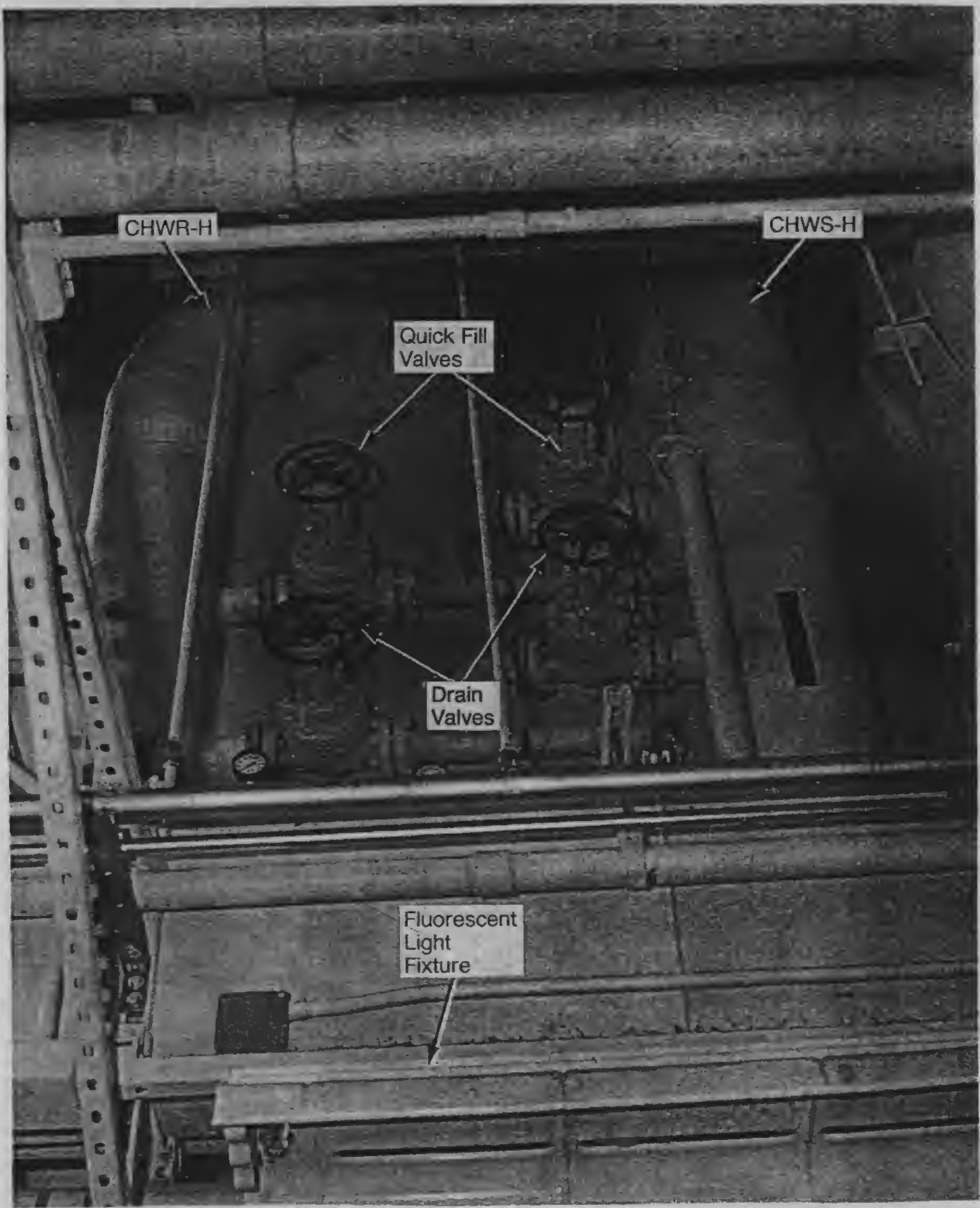


Figure 3.4 Quick-Fill and Drain Valves
Chilled Water System - 75th Floor MER

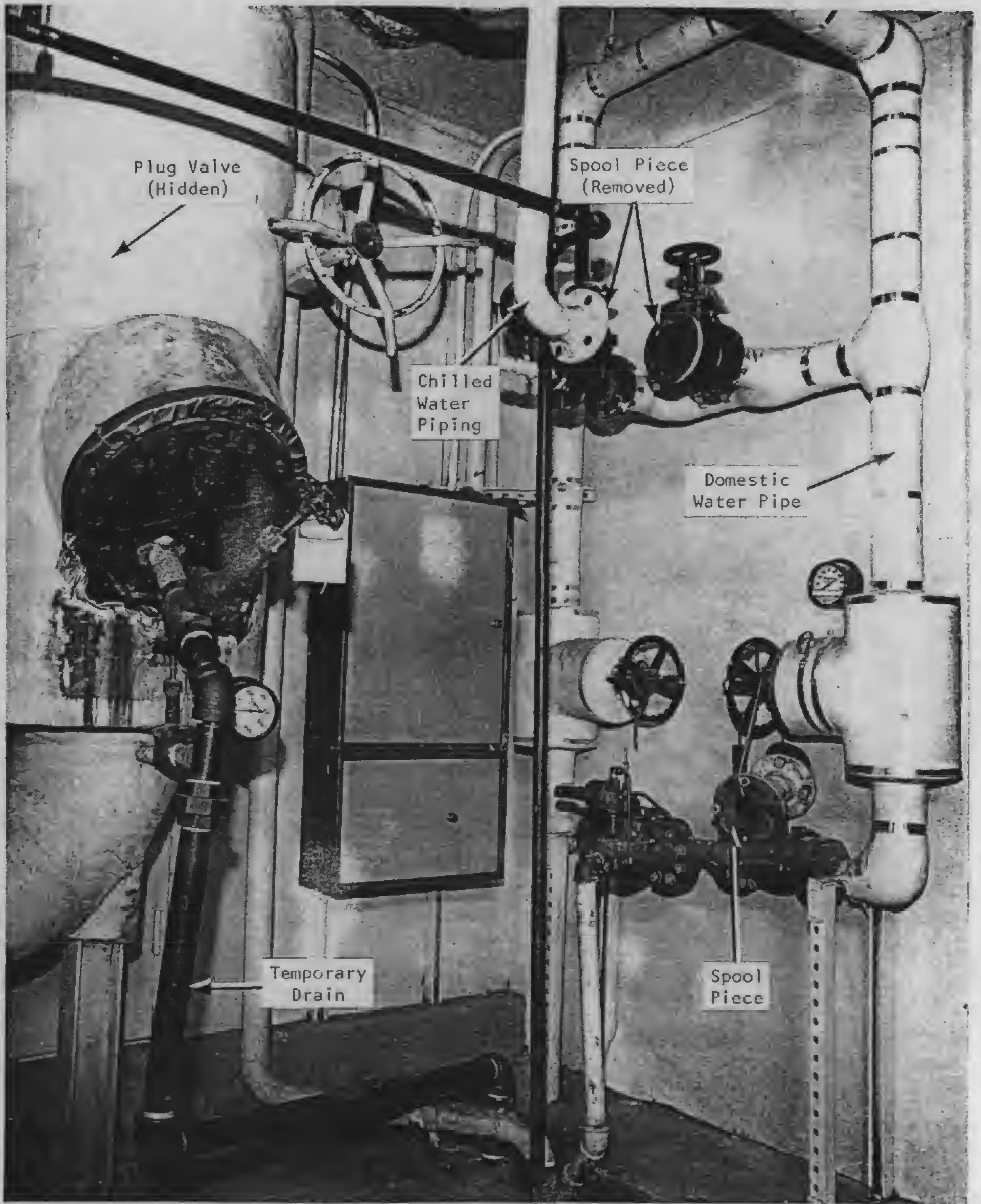


Figure 3.5 Domestic Cold Water Quick-Fill Connection - 75th Floor MER

Figure 3.6 High Zone Expansion Tank
Chilled Water System

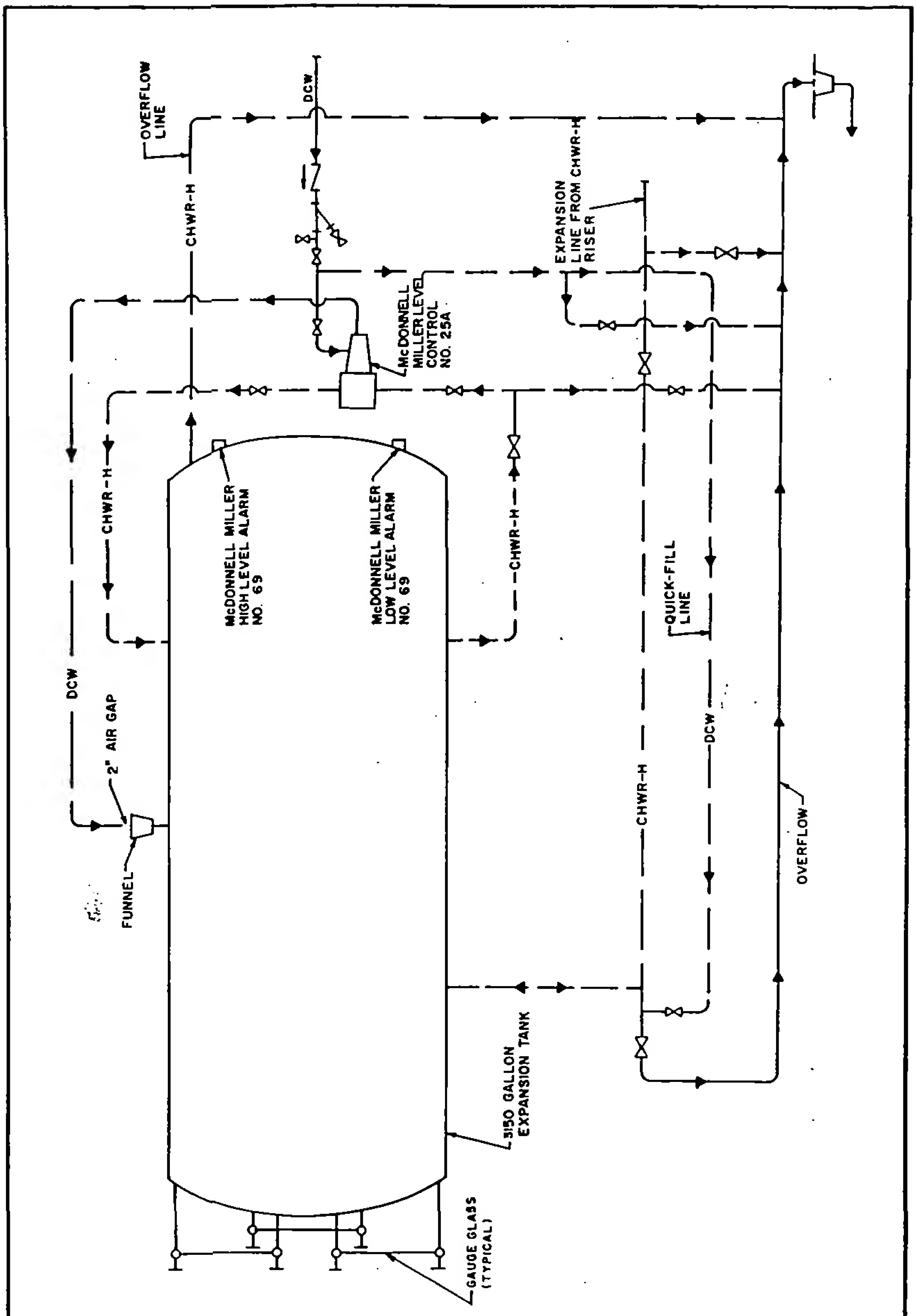


Figure 3.7 Schematic – High Zone Expansion Tank And Piping Chilled Water System

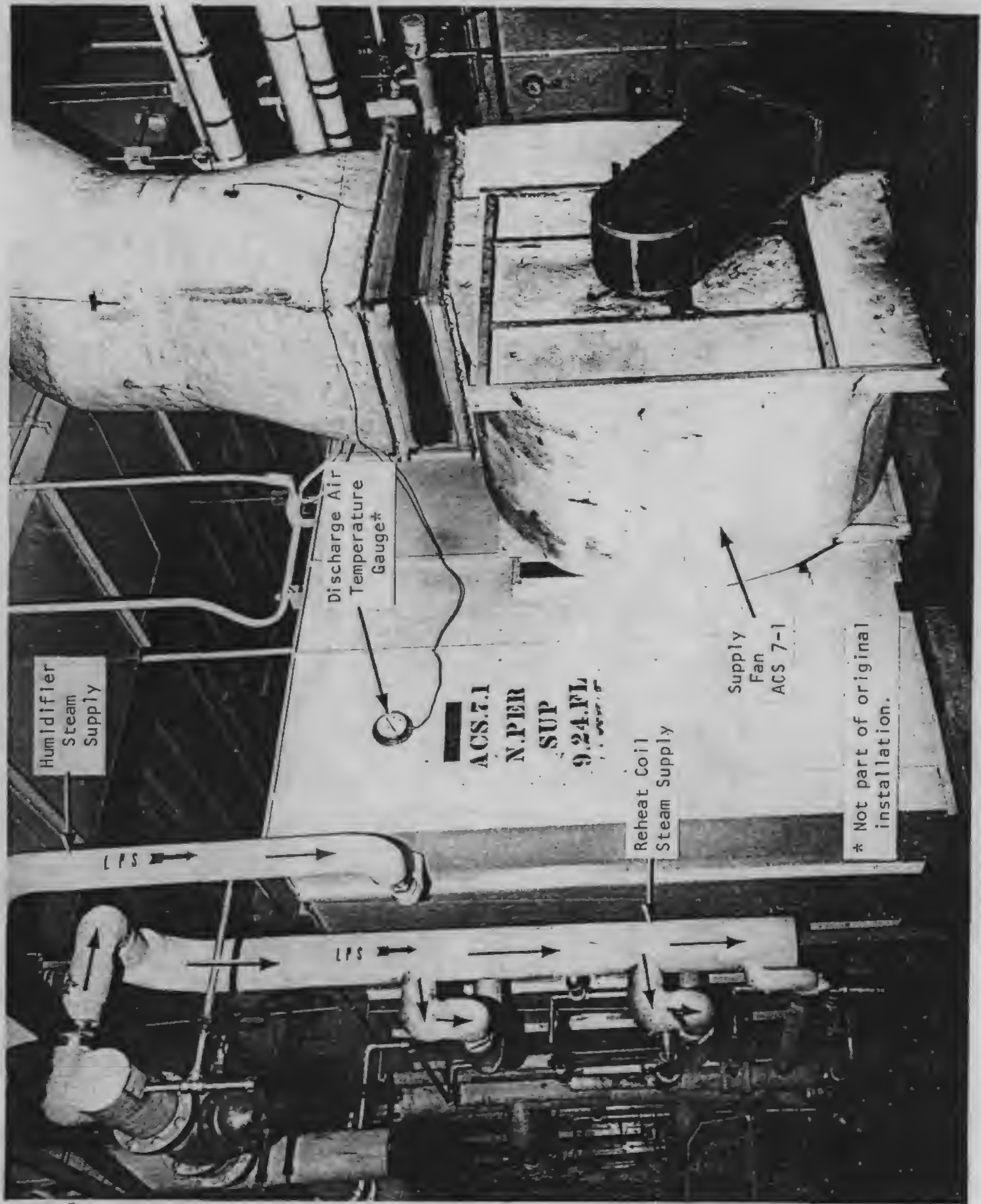


Figure 4.1 Peripheral HVAC Unit ACS 7-1
Left Side View

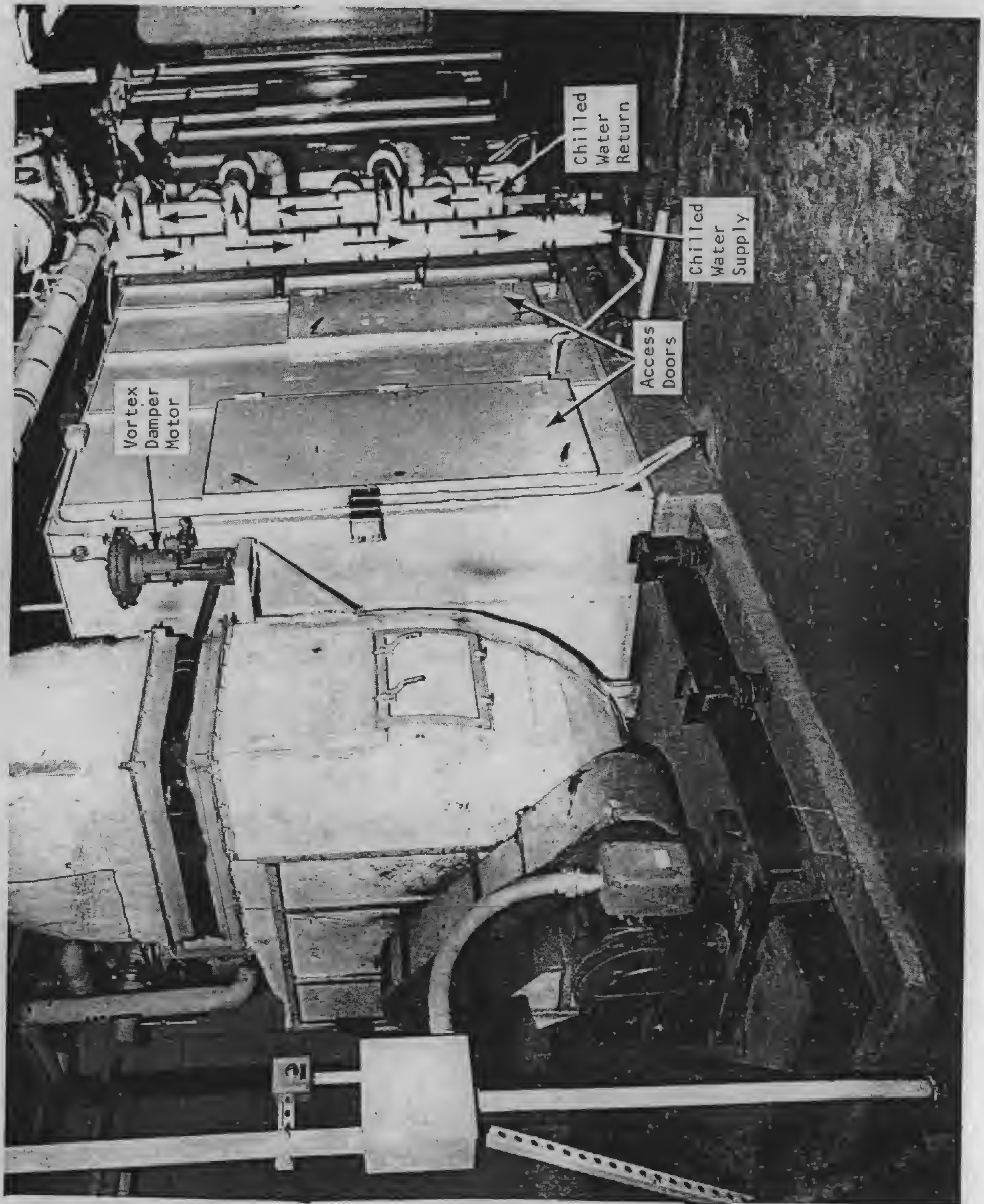


Figure 4.2 Peripheral HVAC Unit ACS 7-1
Right Side View

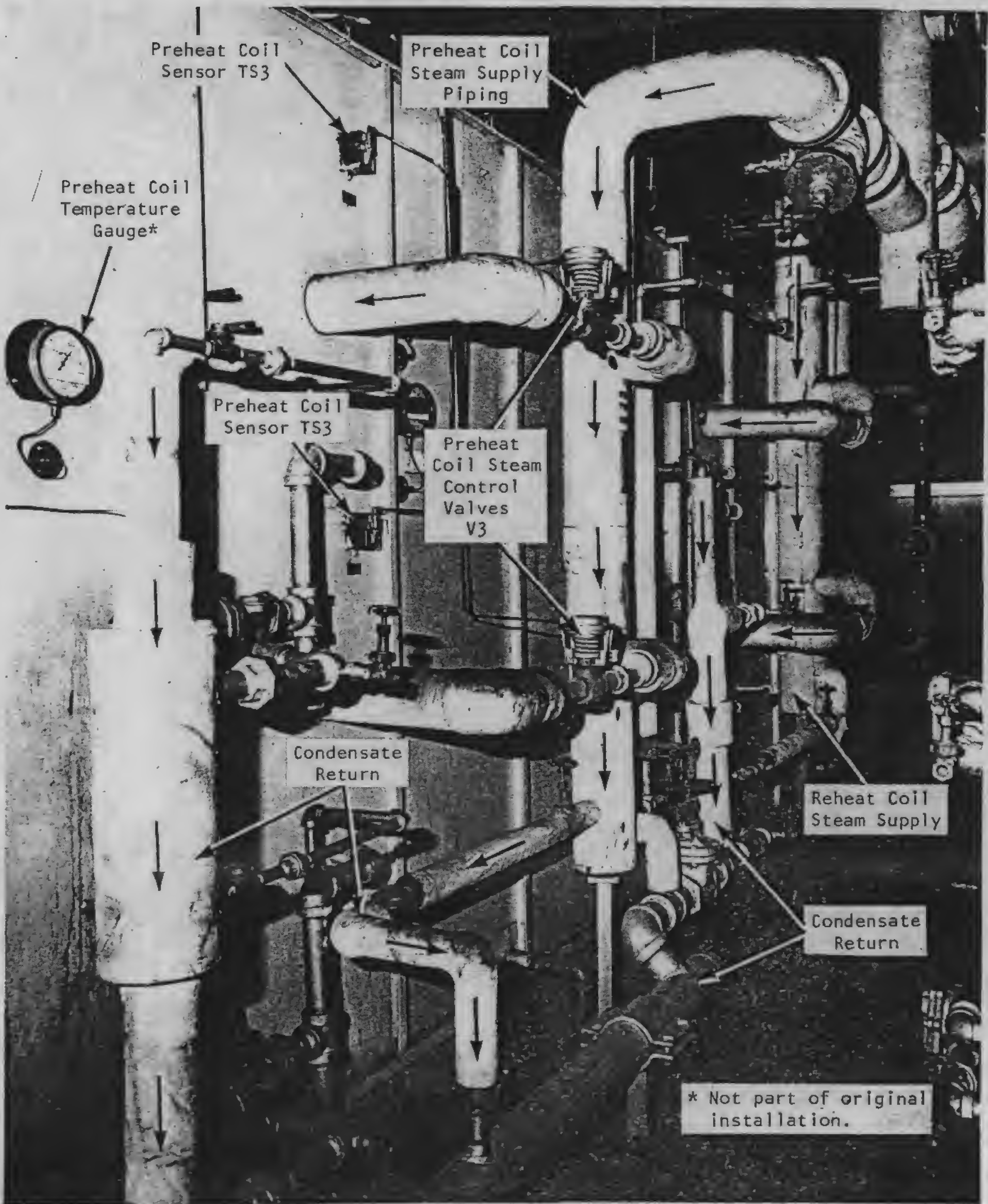


Figure 4.3 Preheat Coil Piping And Valves
Peripheral HVAC Unit ACS 7-2

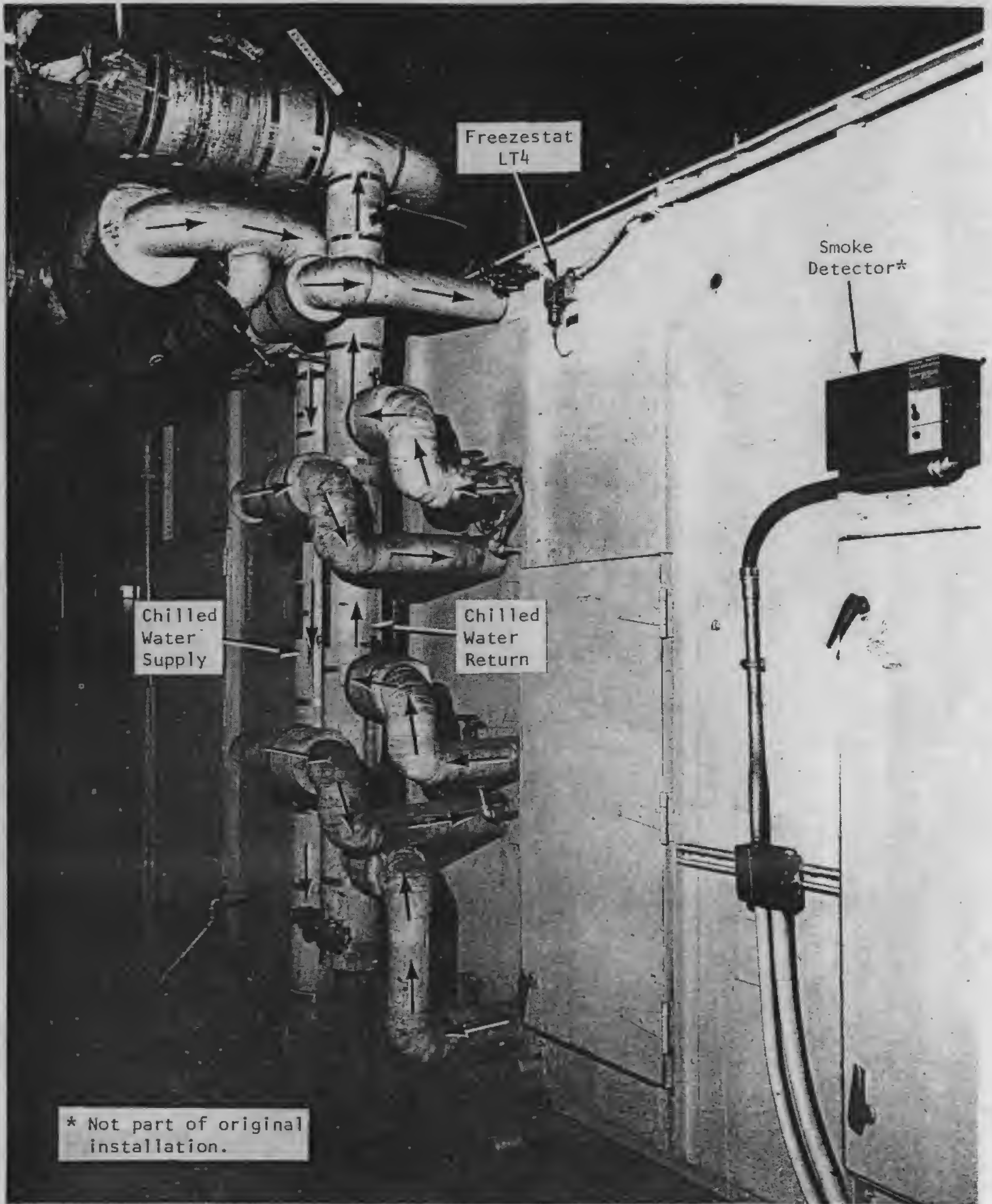


Figure 4.4 Cooling Coil Piping
Peripheral HVAC Unit ACS 7-2

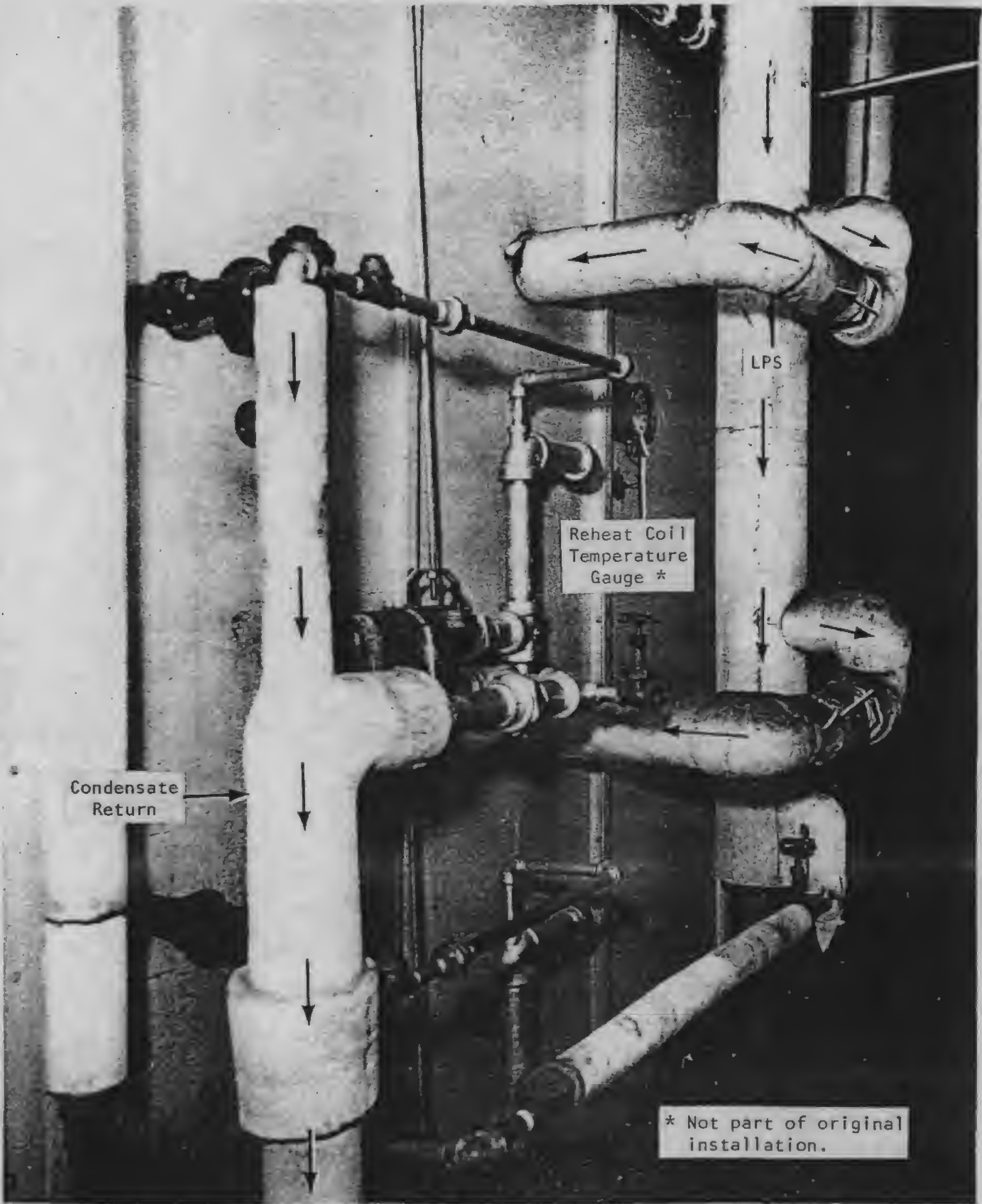


Figure 4.5 Reheat Coil Steam Piping
Peripheral HVAC Unit ACS 7-2

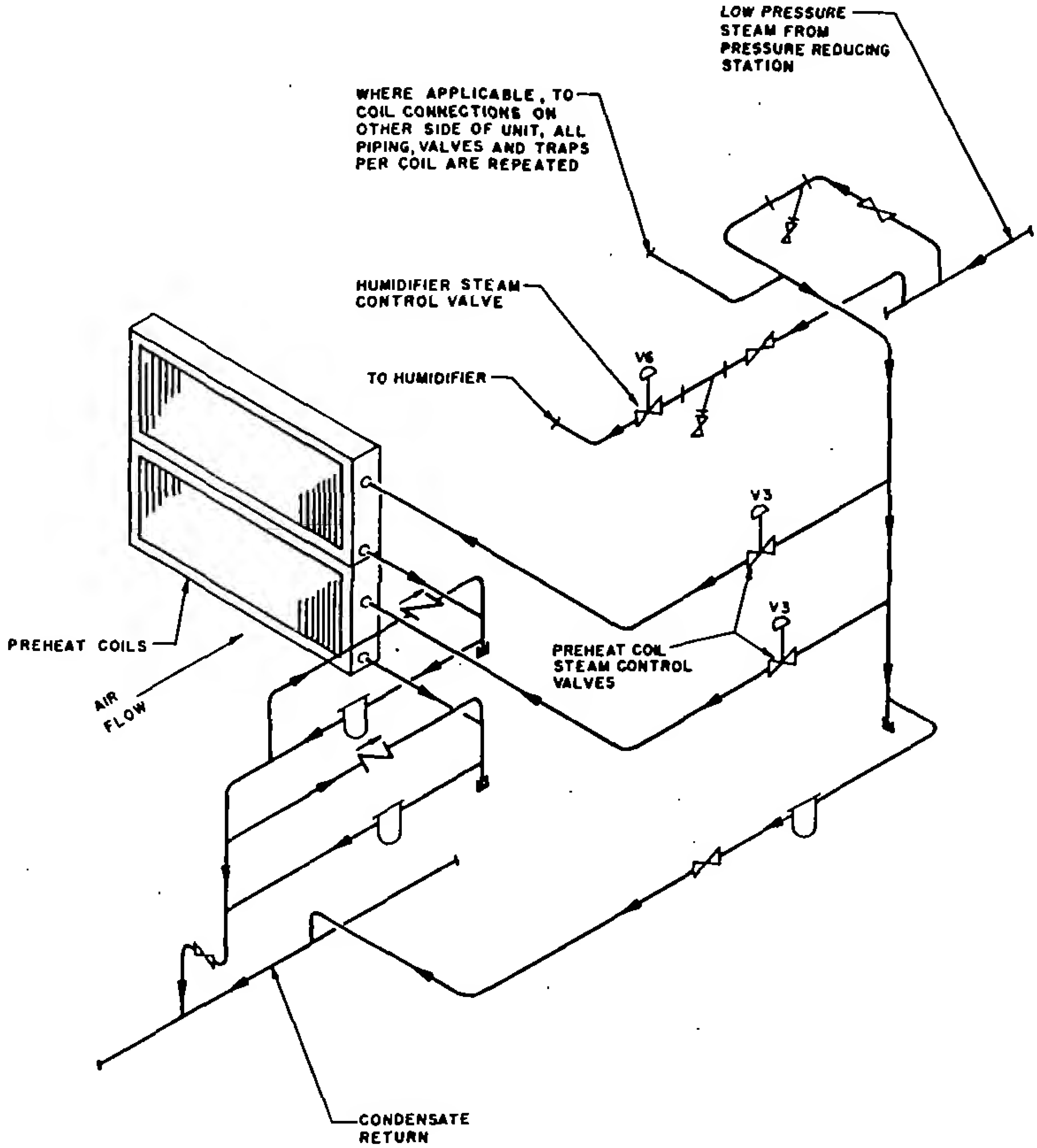


Figure 4.6 Schematic
Typical Preheat Coil And Humidifier Piping

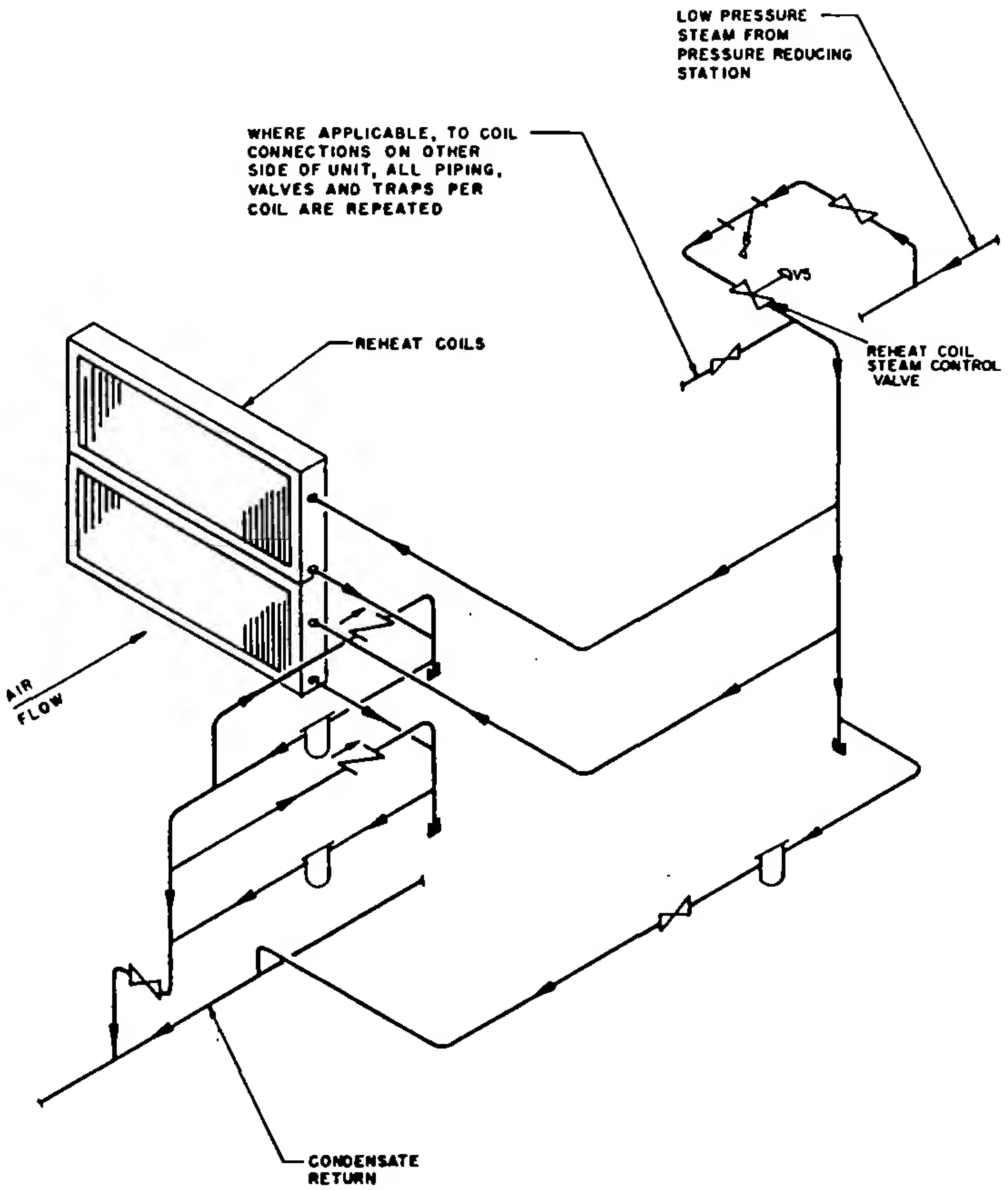


Figure 4.7 Schematic
Typical Reheat Coil Piping

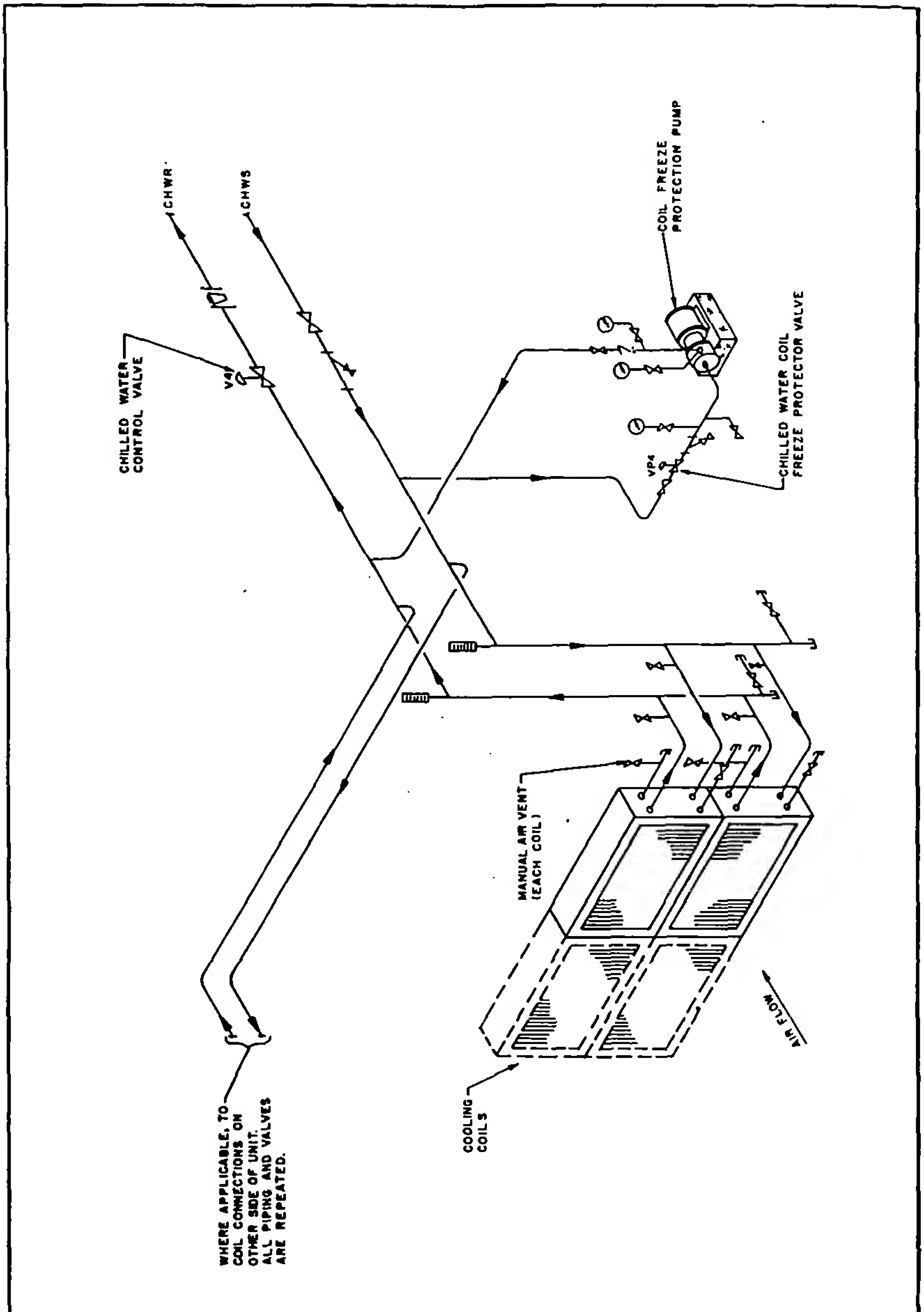


Figure 4.8 Schematic
Typical Cooling Coil & Freeze Protection Piping

Figure 4.9 Control Diagram
East Peripheral HVAC Unit ACS 7-2

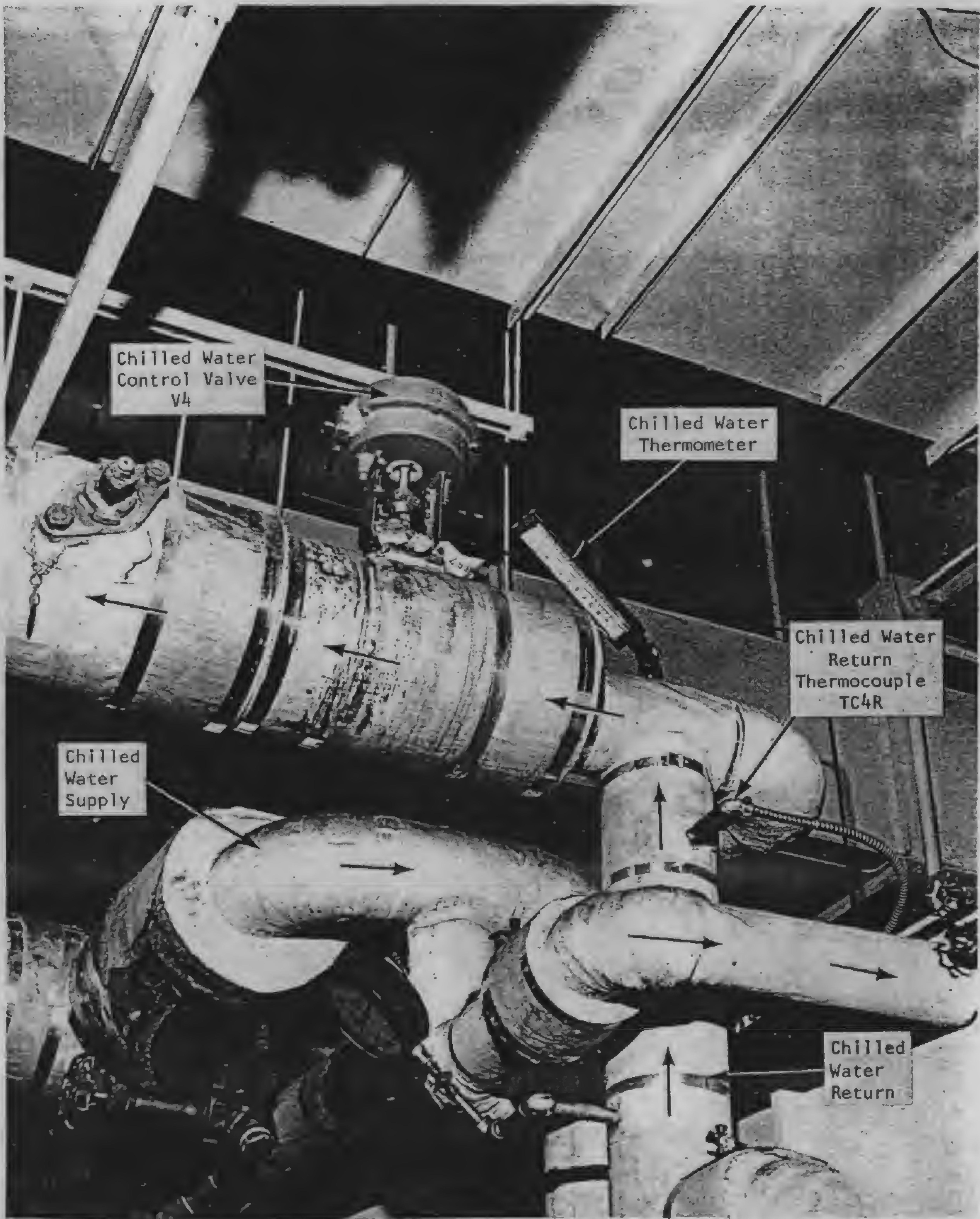


Figure 4.10 Chilled Water Control Valve
Peripheral HVAC Unit ACS 7-1

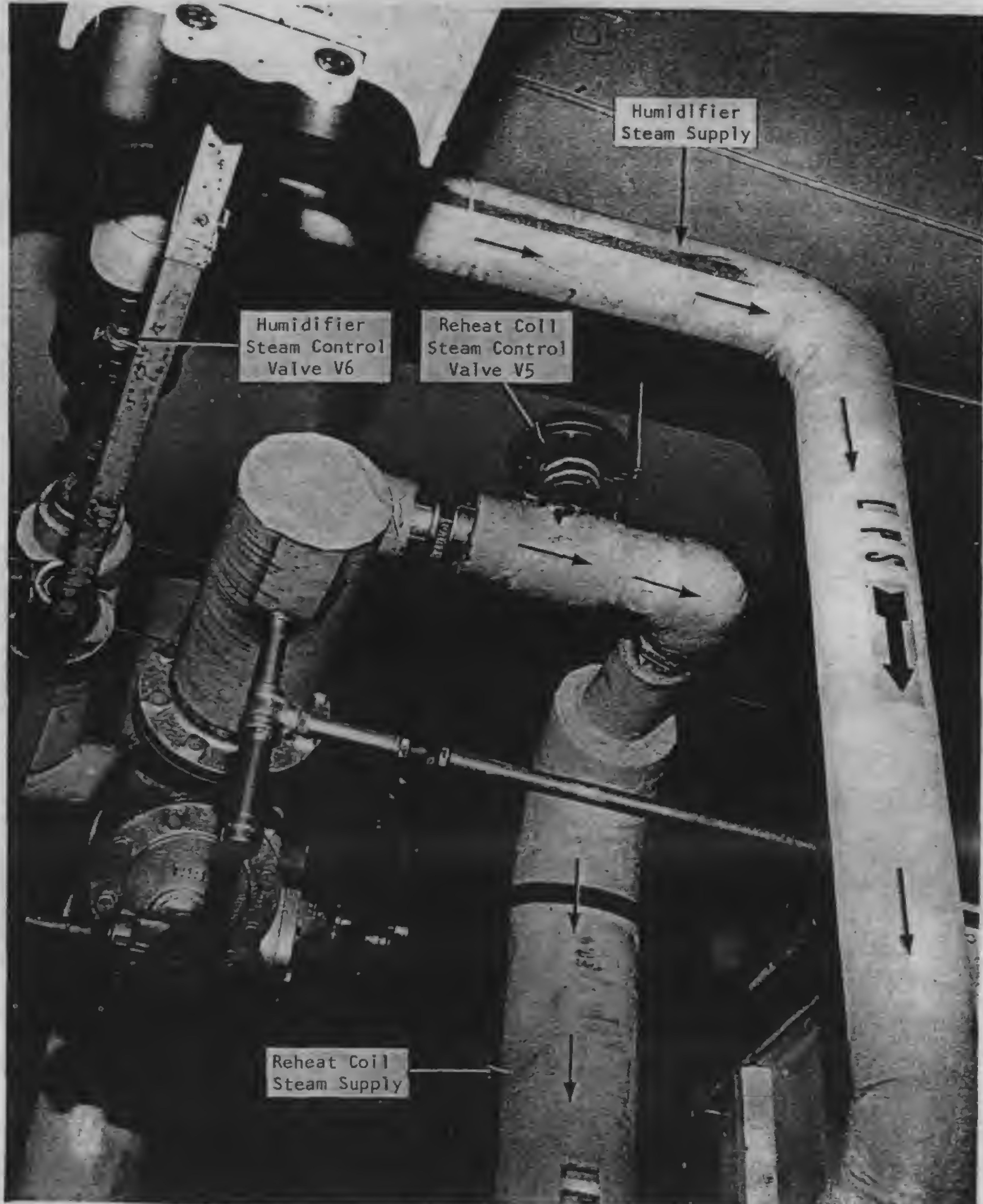


Figure 4.11 Reheat Coil and Humidifier Steam Control Valves and Piping - HVAC Unit ACS 7-1

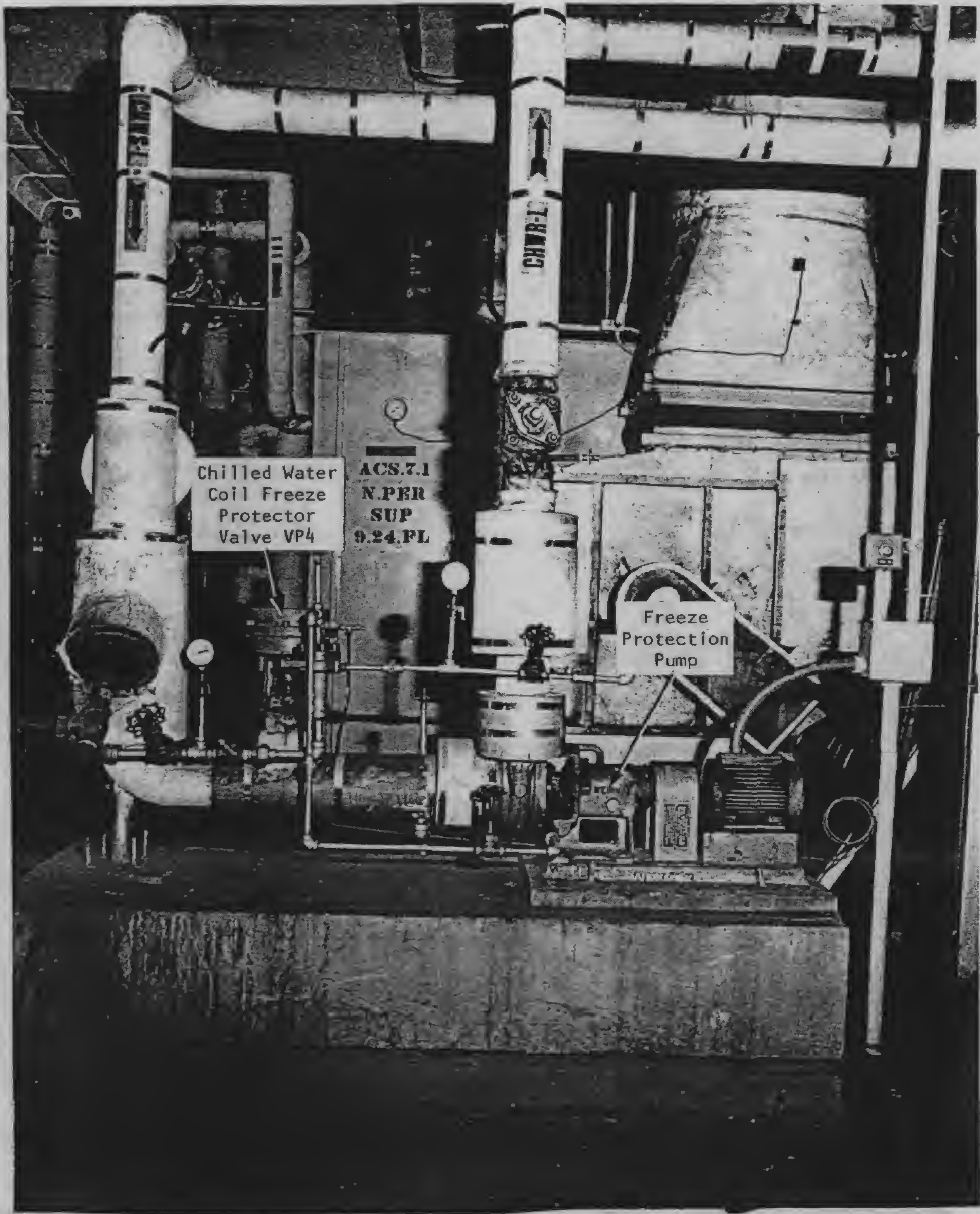


Figure 4.12 Freeze Protection Pump Assembly
Peripheral HVAC Unit ACS 7-1

Figure 4.13 Local Control Panel
Peripheral HVAC Unit ACS 7-1

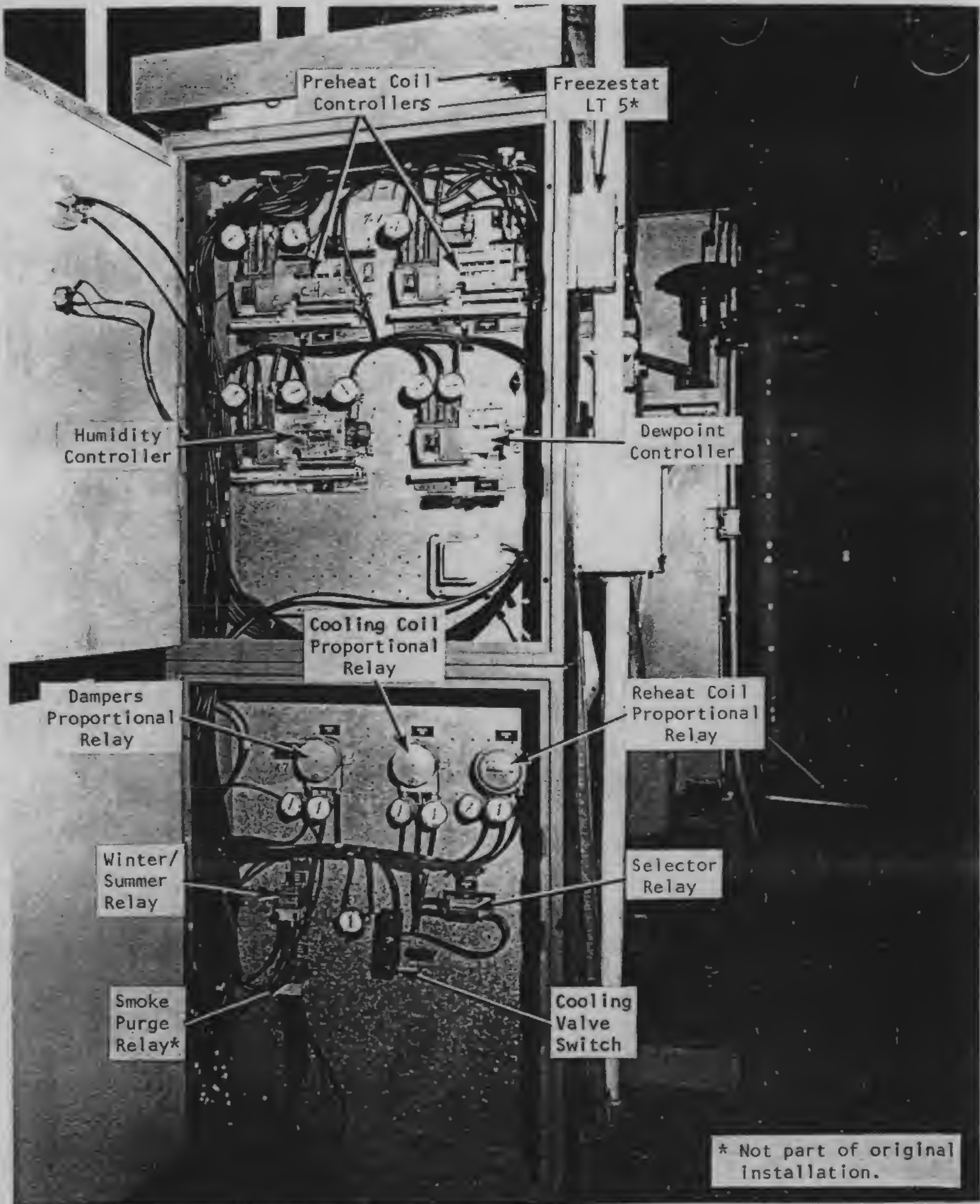


Figure 4.14 Local Control Panel - Interior View
Peripheral HVAC Unit ACS 7-1

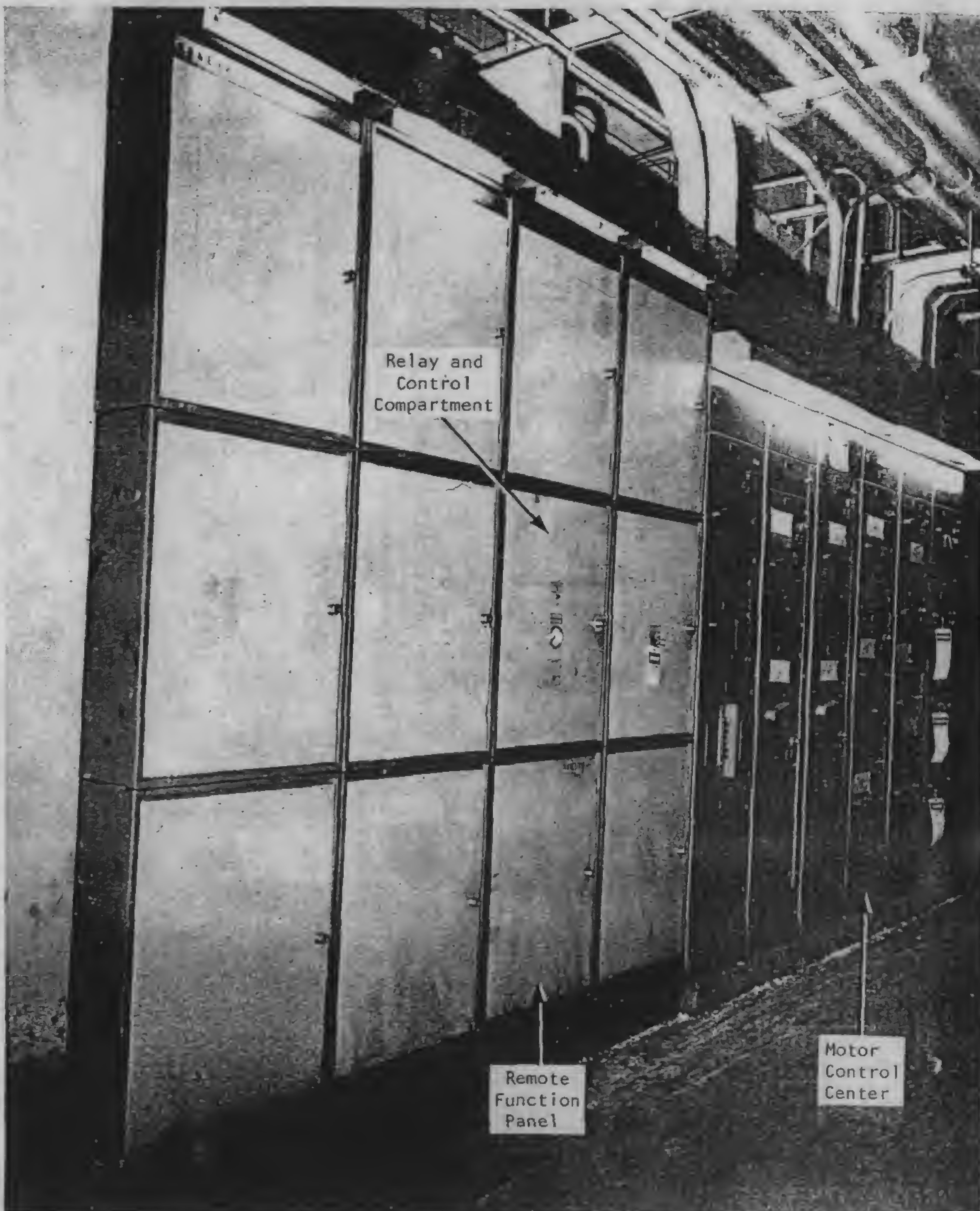


Figure 4.15 Typical Remote Function Panel

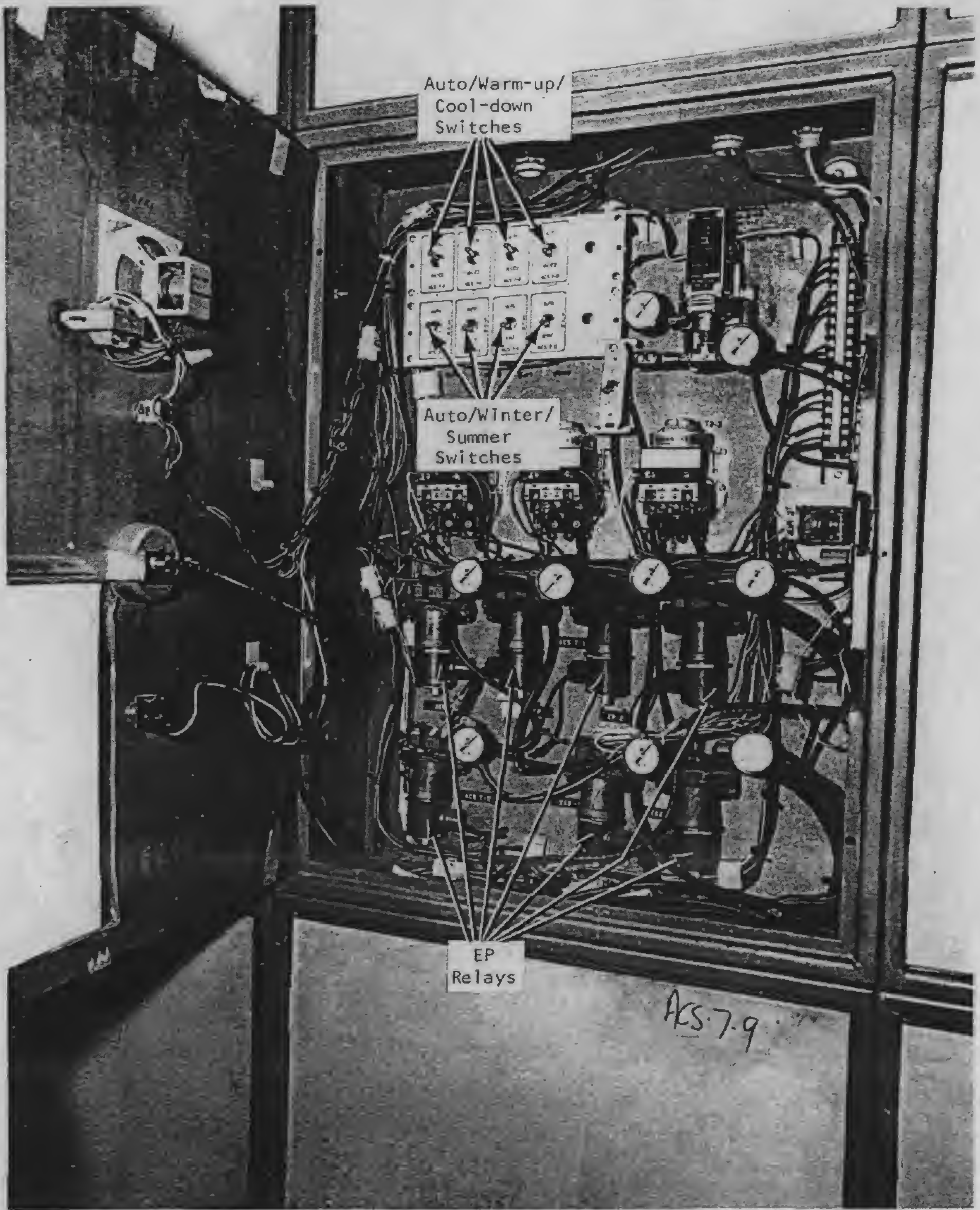


Figure 4.16 Relay and Control Compartment
Remote Function Panel - Interior View

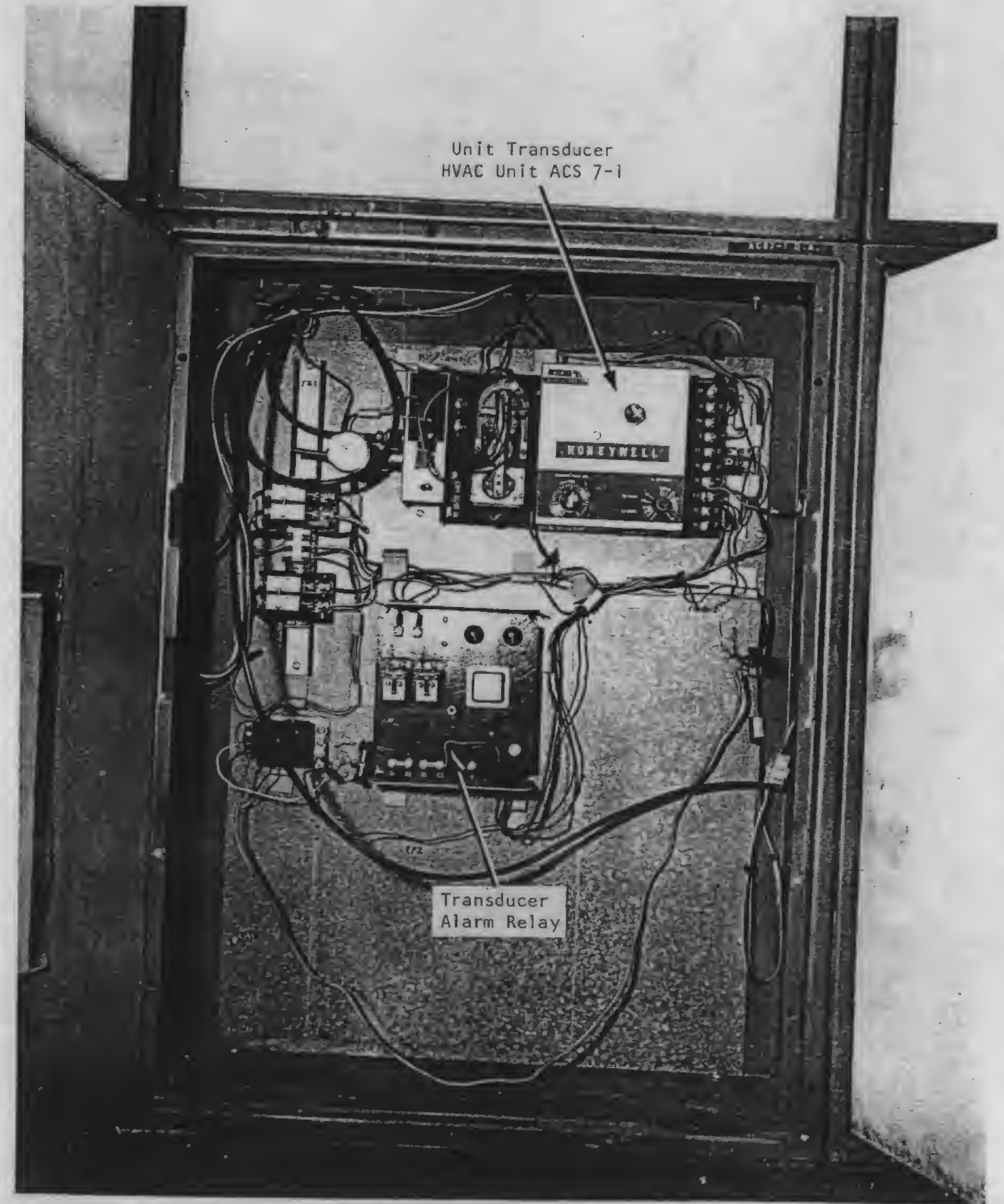


Figure 4.17 Unit ACS 7-1 Transducer Compartment
Remote Function Panel - Interior View

Figure 4.17A Typical Solar Type Master Reset Thermostat

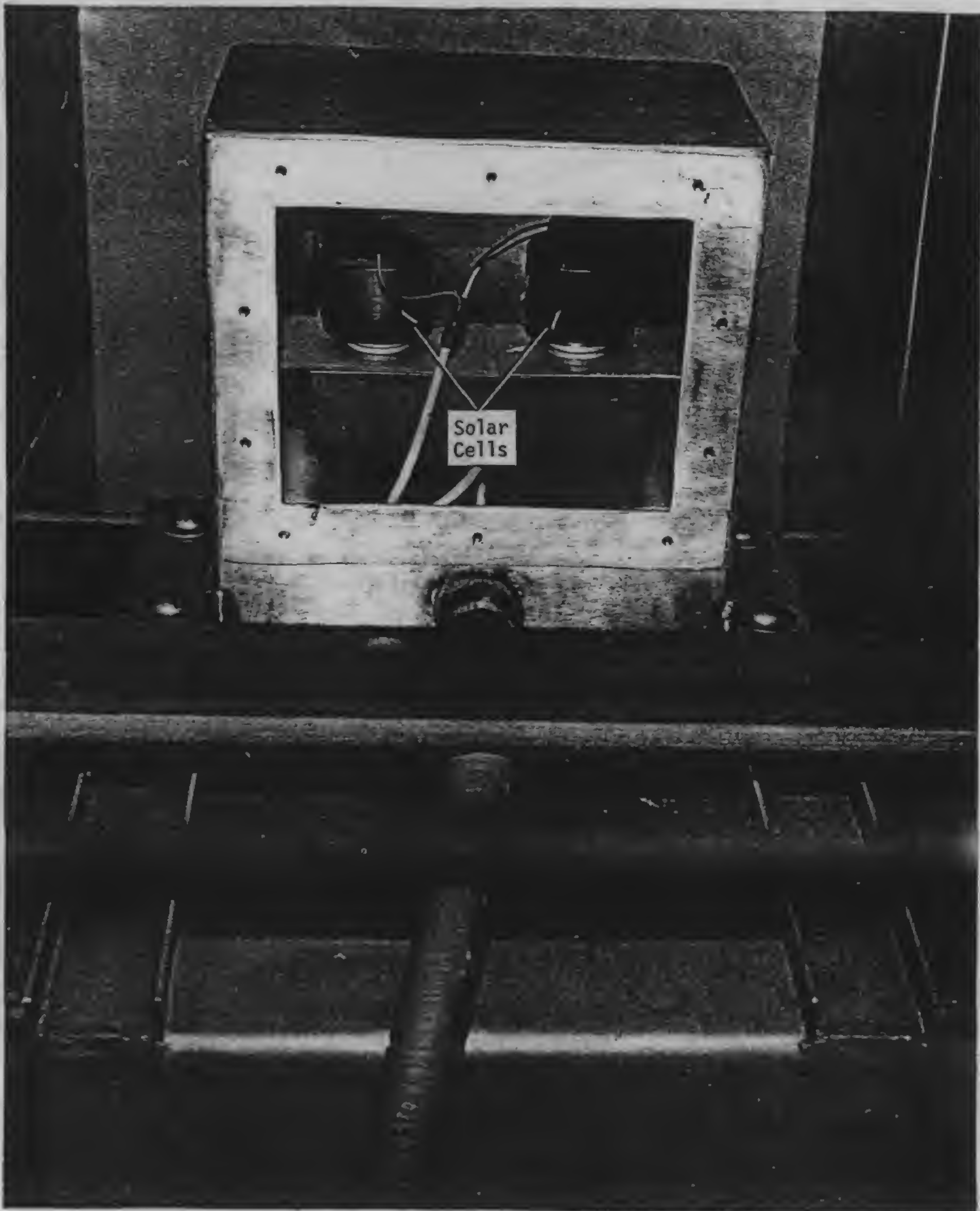


Figure 4.17B Typical Solar Type Master Reset Thermostat
Interior View

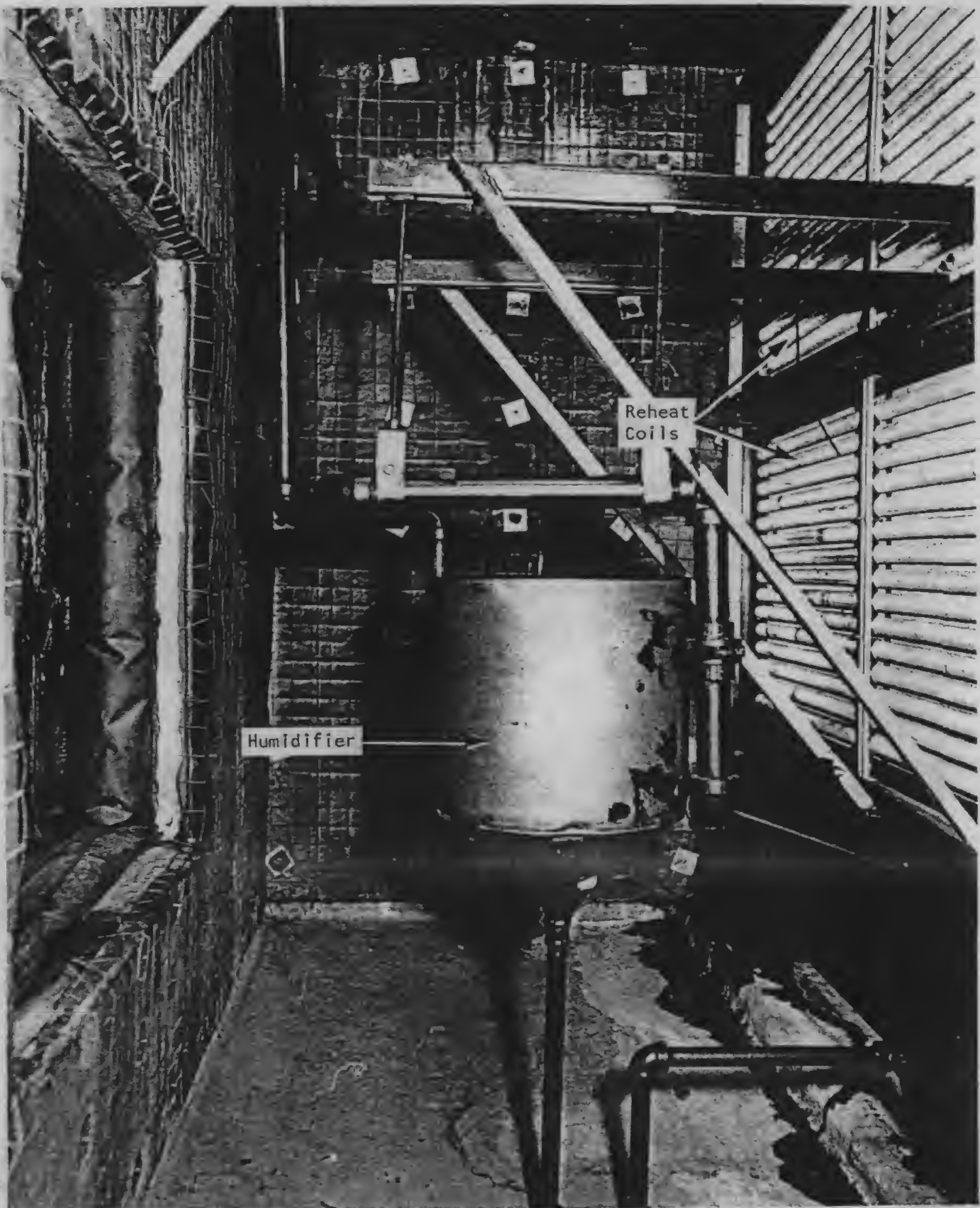


Figure 4.18 Typical Humidifier

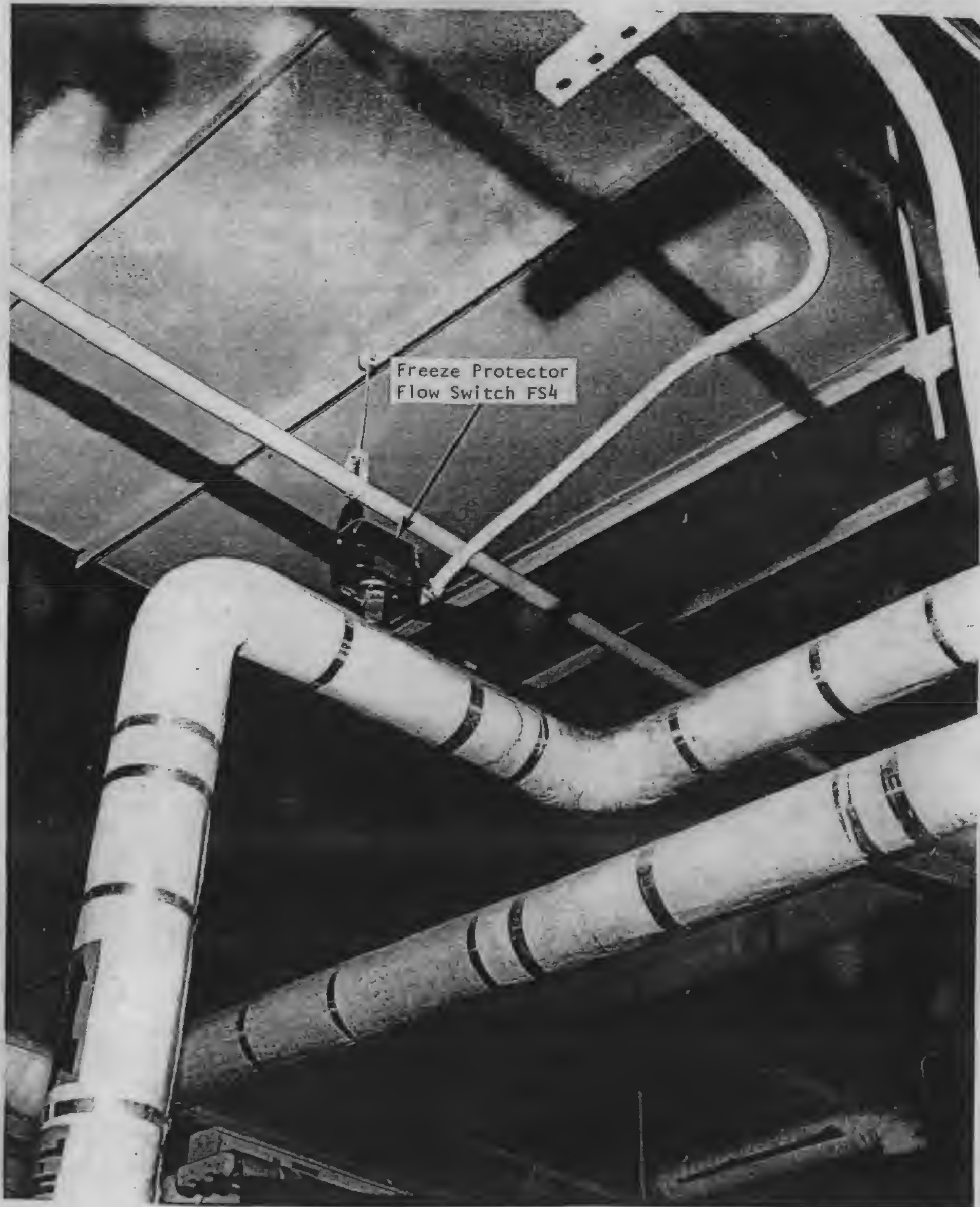


Figure 4.19 Typical Freeze Protector Flow Switch

Figure 4.20 Control Diagram
East Peripheral HVAC Unit ACS 41-2

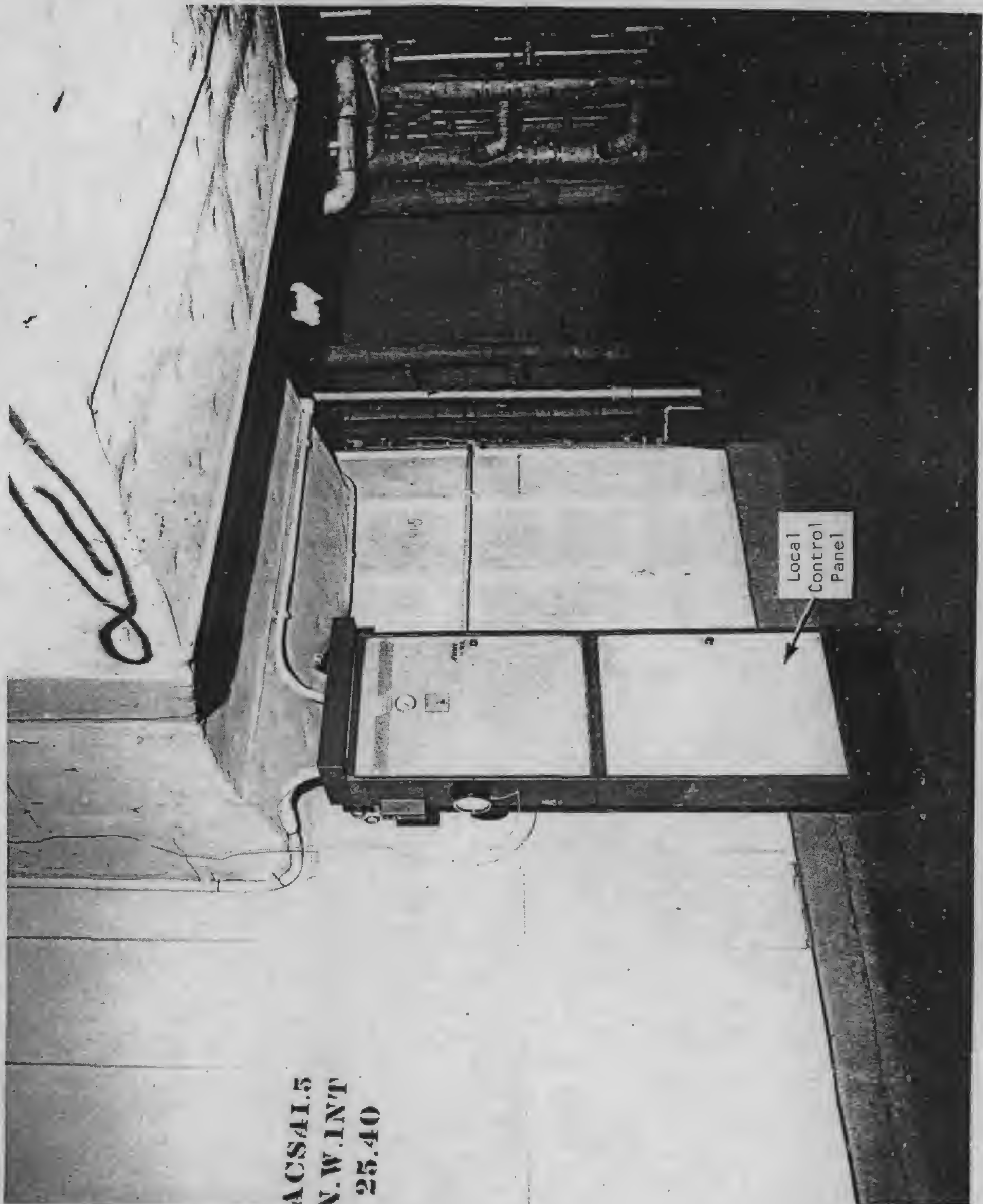


Figure 4.21 Interior HVAC Unit ACS 41-5
Front View

Figure 4.22 **Control Diagram**
Interior HVAC Unit ACS 41-5 — Tower A

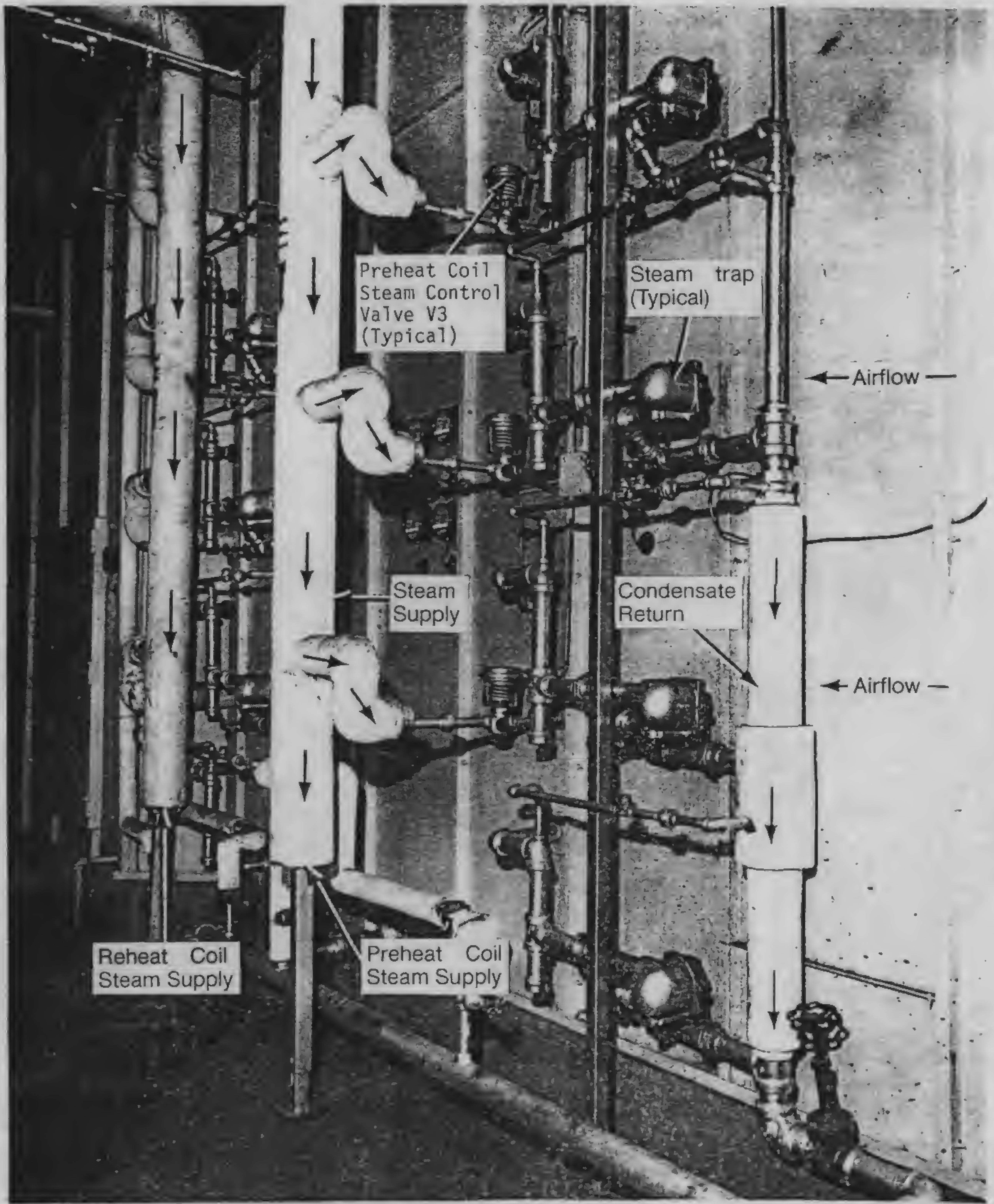


Figure 4.23 Preheat and Reheat Coil Piping
Core HVAC Unit ACS 7-10

Figure 4.24 Control Diagram
Core HVAC Unit ACS 7-10

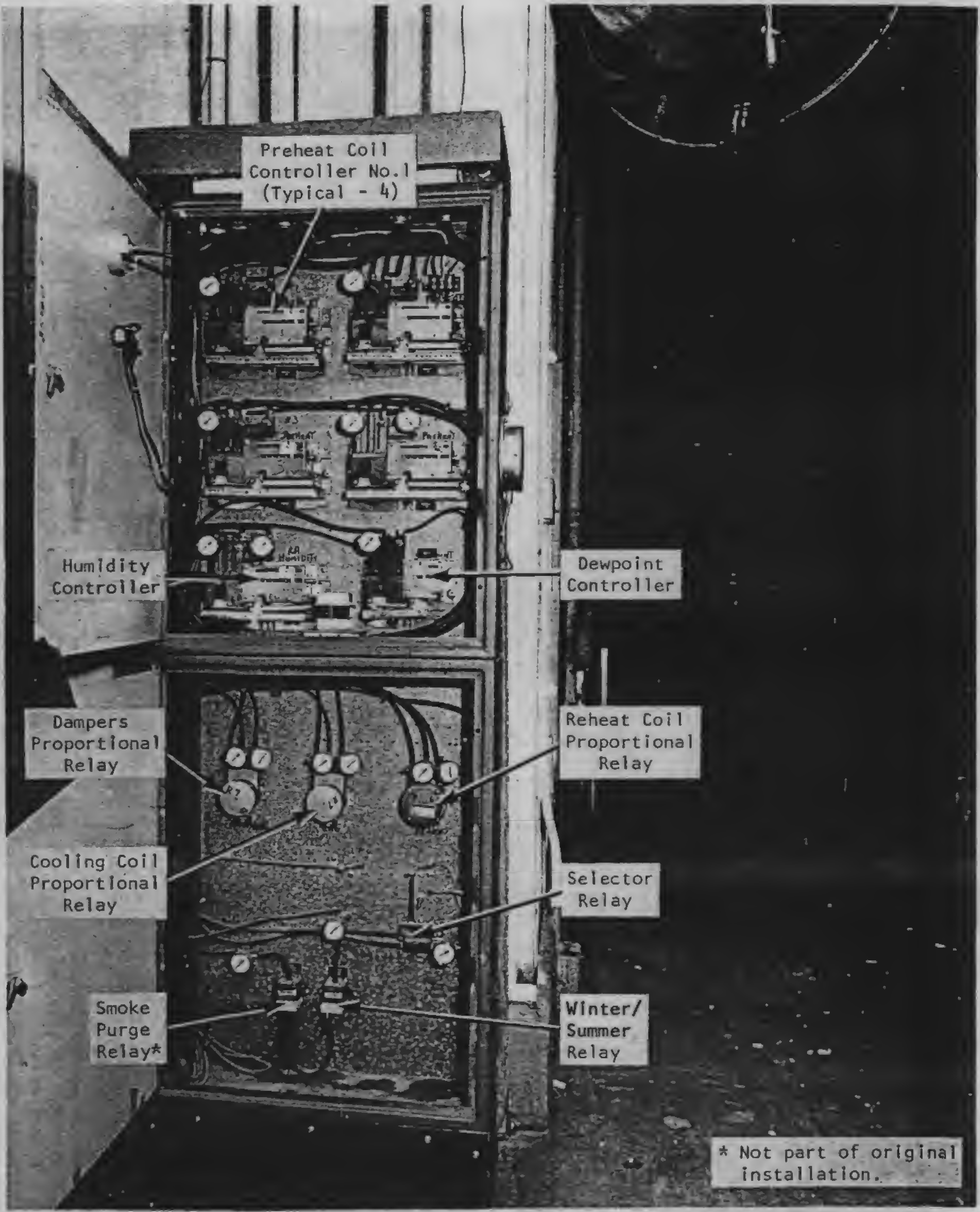


Figure 4.25 Local Control Panel
Core HVAC Unit ACS 7-10
Interior View

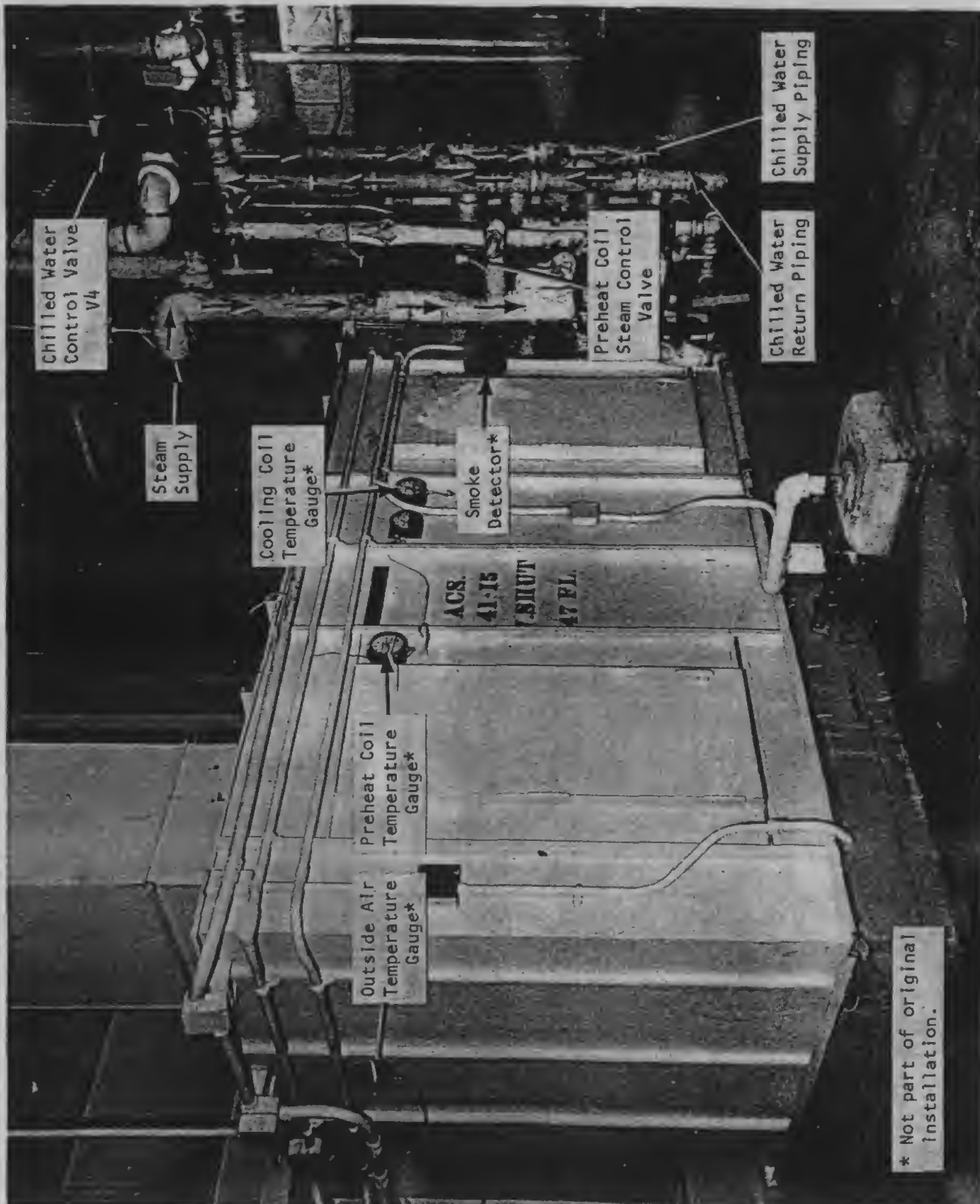


Figure 4.26 Shuttle Elevator Machine Room HVAC Unit ACS 41-15—Left Side View

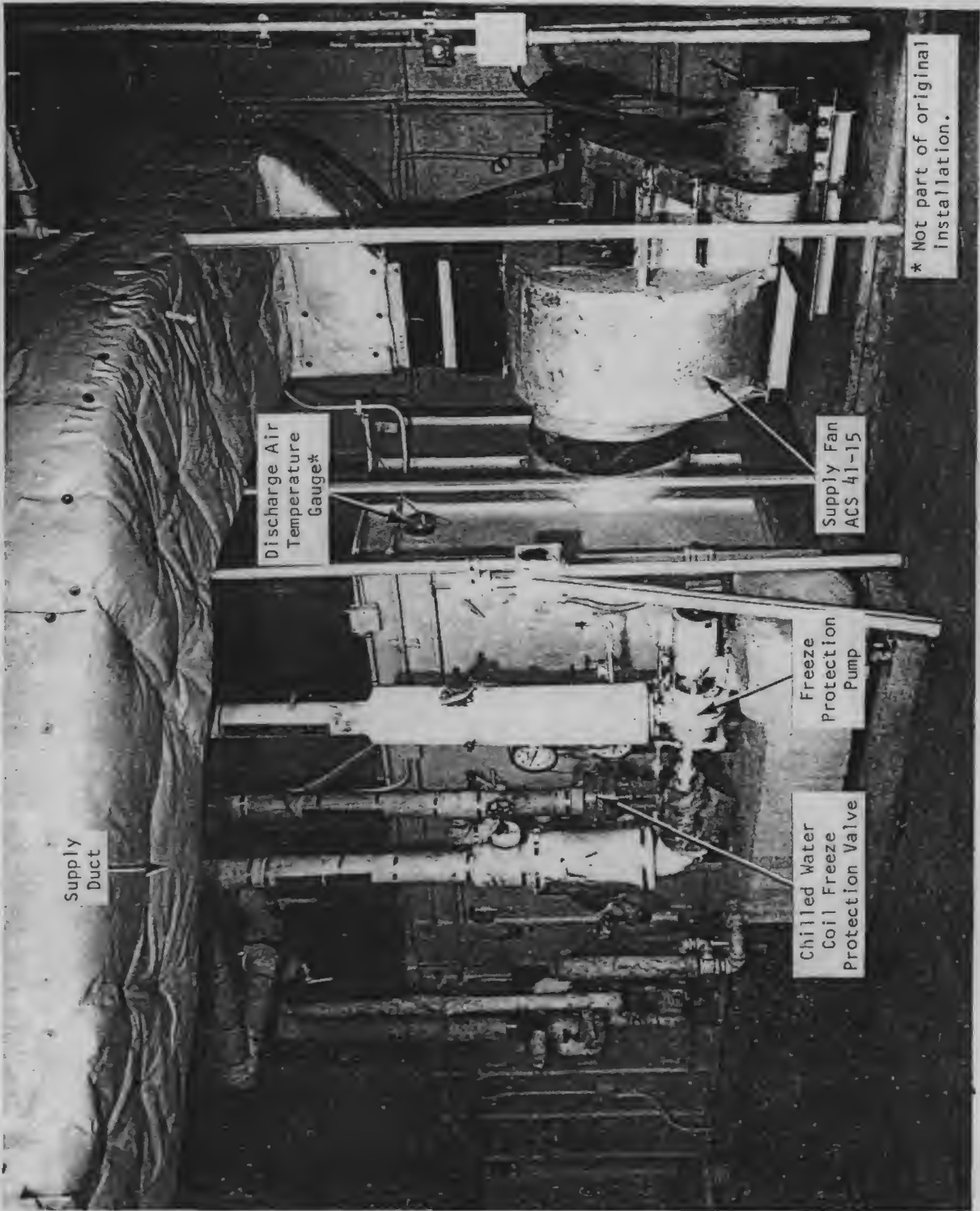


Figure 4.27 **Shuttle Elevator Machine Room**
HVAC Unit ACS 41-15—Right Side View

Figure 4.28 Control Diagram
Shuttle Elevator Machine Room HVAC Unit ACS 41-15

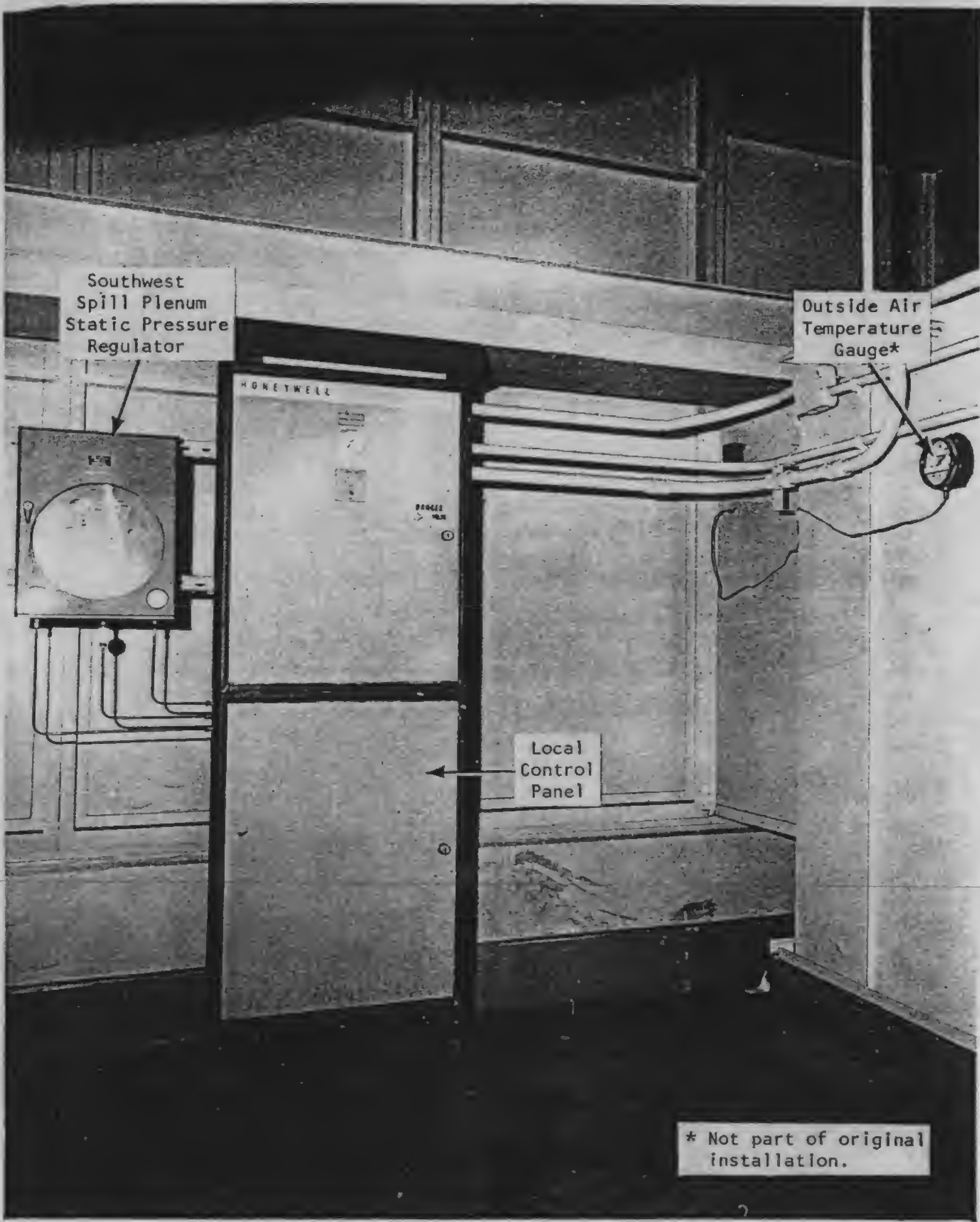


Figure 4.29 Local Control Panel—Shuttle Elevator Machine Room HVAC Unit ACS 41-15

Figure 4.30 Typical Centrifugal Return Air Fan

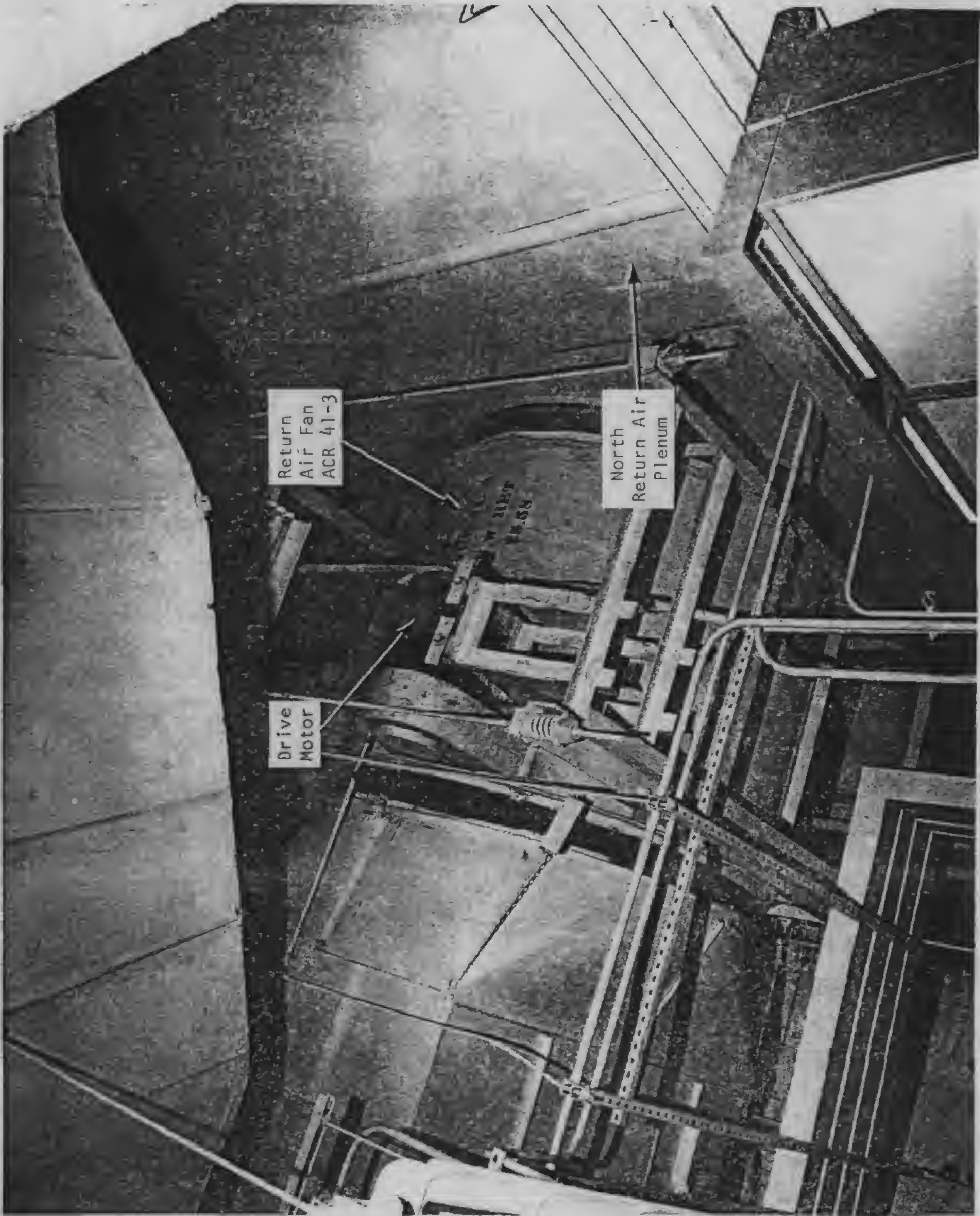
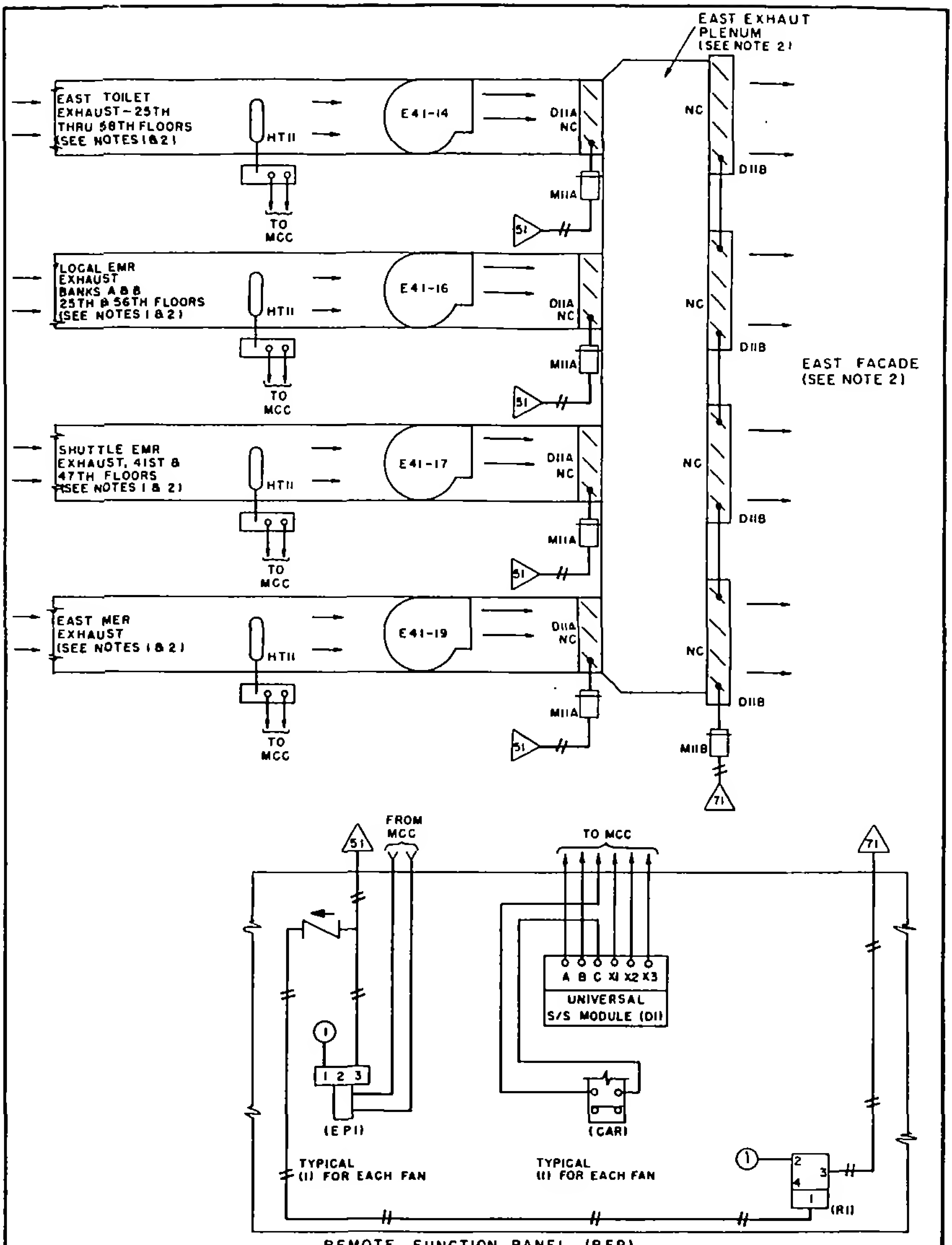


Figure 4.31 Typical In-Line Return Air Fan

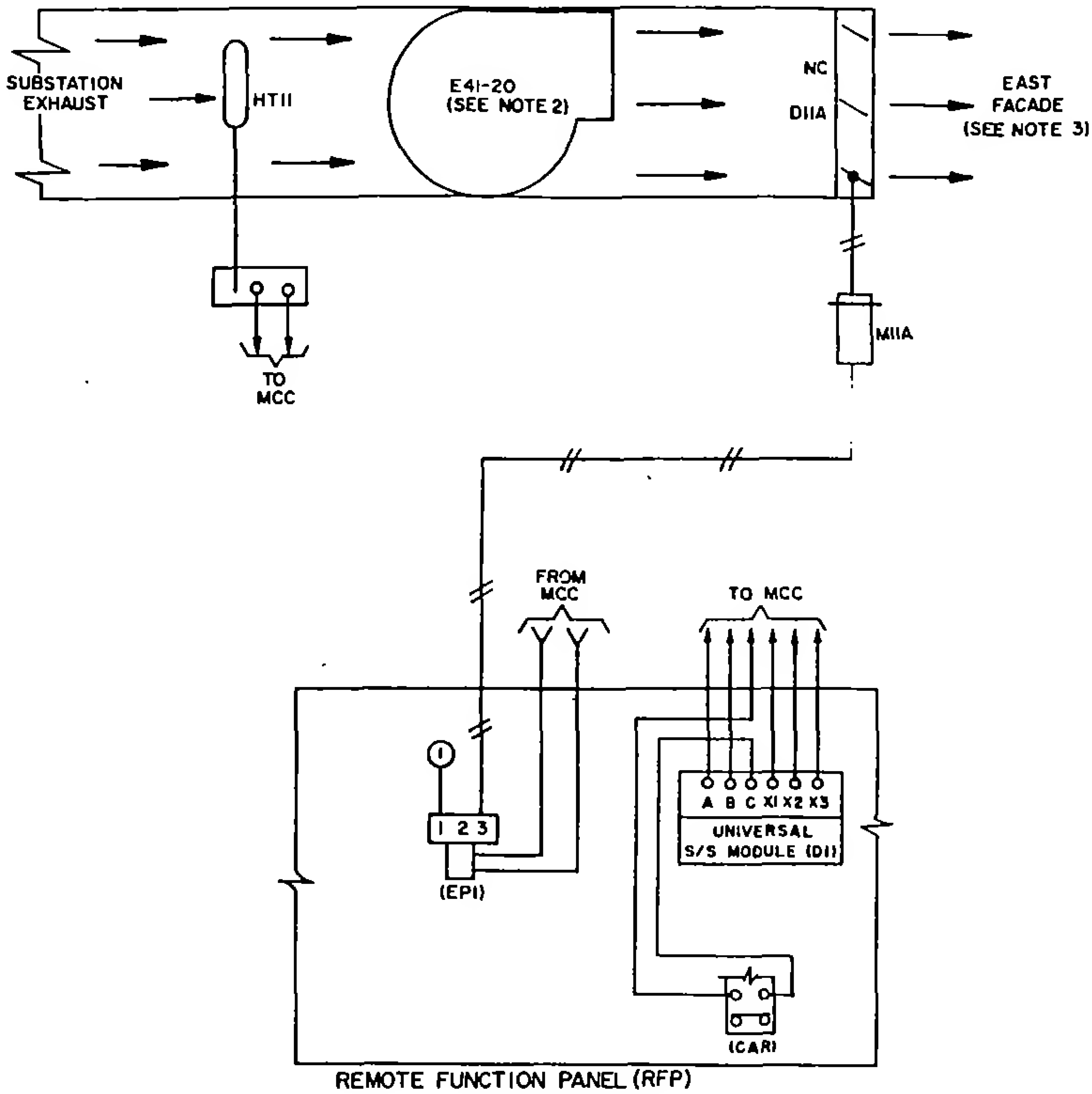
Figure 4.32 Control Diagram
Return Air Fans ACR 7-1 Thru ACR 7-8 — Tower A



NOTES
1. THIS DRAWING IS TYPICAL FOR ALL TOILET, EMR, AND MER EXHAUSTS IN THE 7TH, 41ST AND 75TH FLOOR MERS.
2. FOR TOWER B, THE COMPASS DESIGNATIONS CHANGE AS FOLLOWS:

TOWER A		TOWER B
NORTH	BECOMES	WEST
SOUTH	"	EAST
WEST	"	SOUTH
EAST	"	NORTH

Figure 4.33 Control Diagram - Exhaust Fans East Exhaust Plenum - 41st Floor MER - Tower A

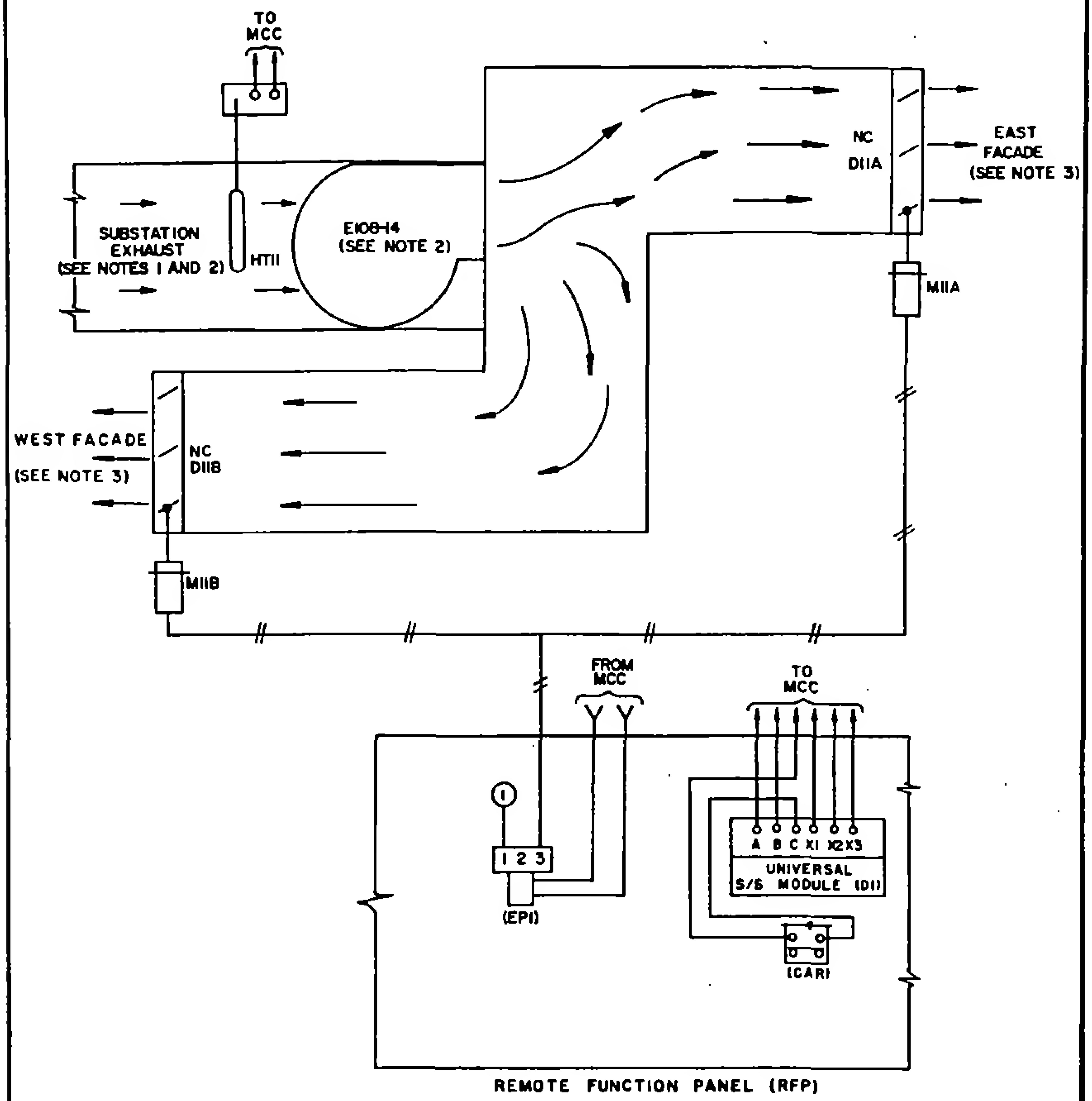


NOTES

1. THIS FIGURE IS TYPICAL FOR ALL ELECTRIC SUBSTATION EXHAUSTS IN THE 7th, 41st, AND 75th FLOOR MERs AND THE TOILET, MER, AND EMR EXHAUSTS IN THE 108th FLOOR MERs—TOWERS A AND B.
2. THE SOUTH ELECTRIC SUBSTATION EXHAUST FAN DESIGNATION IS E41-21.
3. FOR TOWER B, THE COMPASS DESIGNATIONS CHANGE AS FOLLOWS:

TOWER A		TOWER B
NORTH	BECOMES	WEST
SOUTH	"	EAST
WEST	"	SOUTH
EAST	"	NORTH

Figure 4.34 Control Diagram—Exhaust Fan North Electric Substation—41st Floor MER-Tower A



NOTES:

1. THIS FIGURE IS TYPICAL FOR THE SOUTH ELECTRIC SUBSTATION.
2. THE SOUTH SUBSTATION EXHAUST FAN DESIGNATION IS E108-15.
3. FOR TOWER B, THE COMPASS DESIGNATIONS CHANGE AS FOLLOWS:

TOWER A		TOWER B
NORTH	BECOMES	WEST
SOUTH	"	EAST
WEST	"	SOUTH
EAST	"	NORTH

Figure 4.35 Control Diagram - Exhaust Fan North Electric Substation—108th Floor MER—Tower A

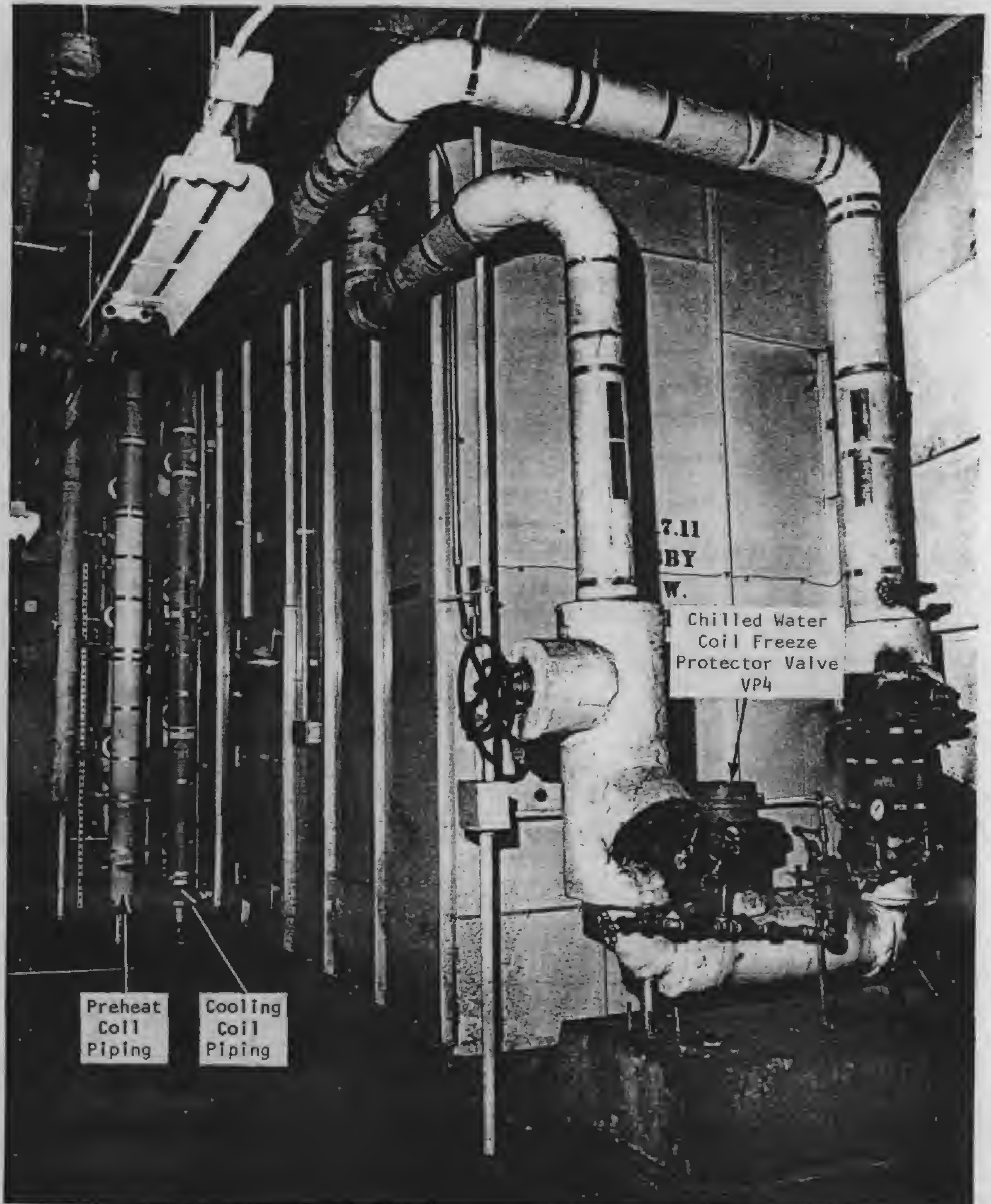


Figure 4.36 Lobby HVAC Unit ACS 7-11
Left Side View

Figure 4.37 Control Diagram
Second Floor Lobby HVAC Units ACS 7-11 & 7-12

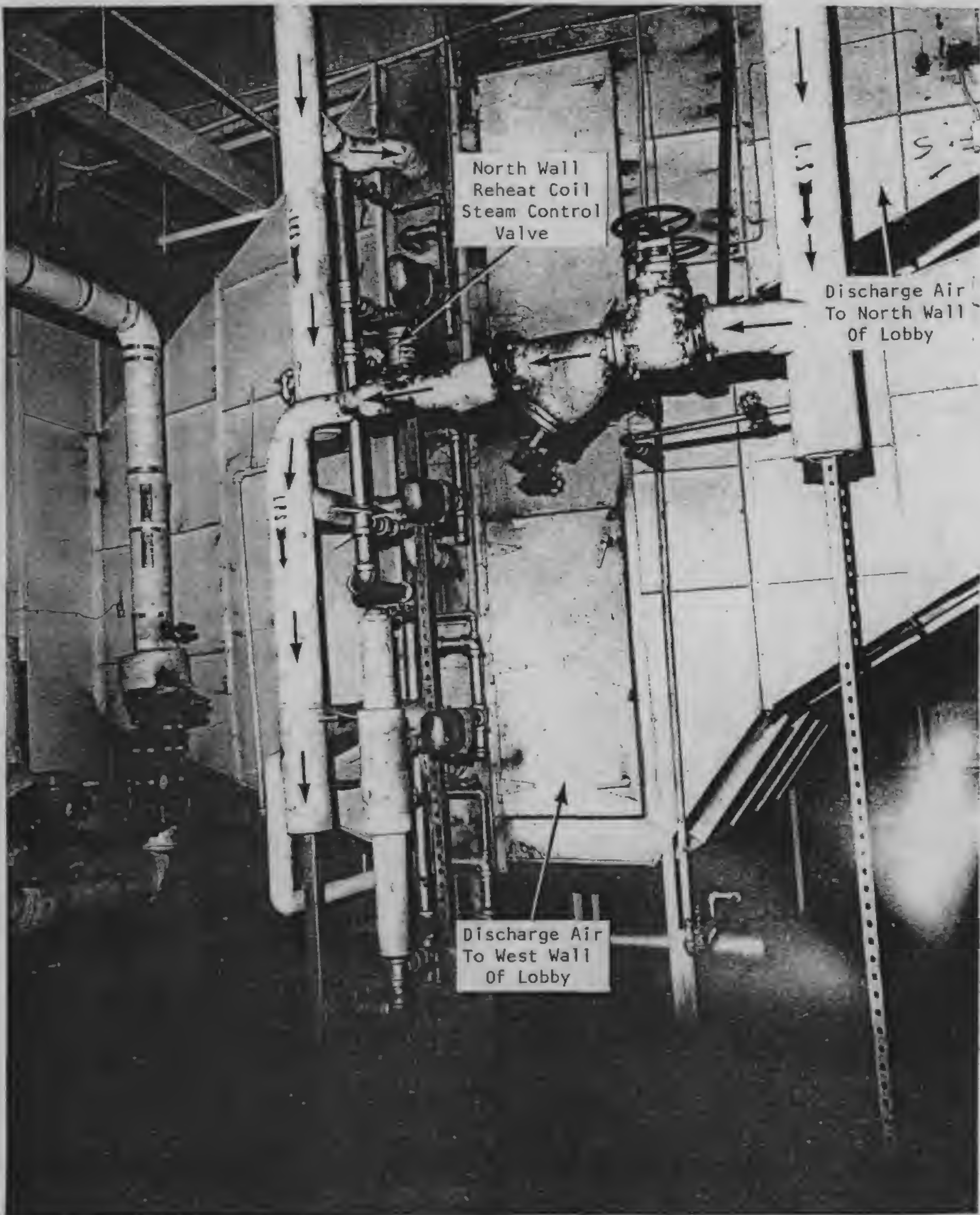


Figure 4.38 Reheat Coil Steam Piping And Control Valves
Lobby HVAC Unit ACS 7-11

Figure 4.39 Control Diagram
Second Floor Lobby Interior HVAC Unit ACS 7-13

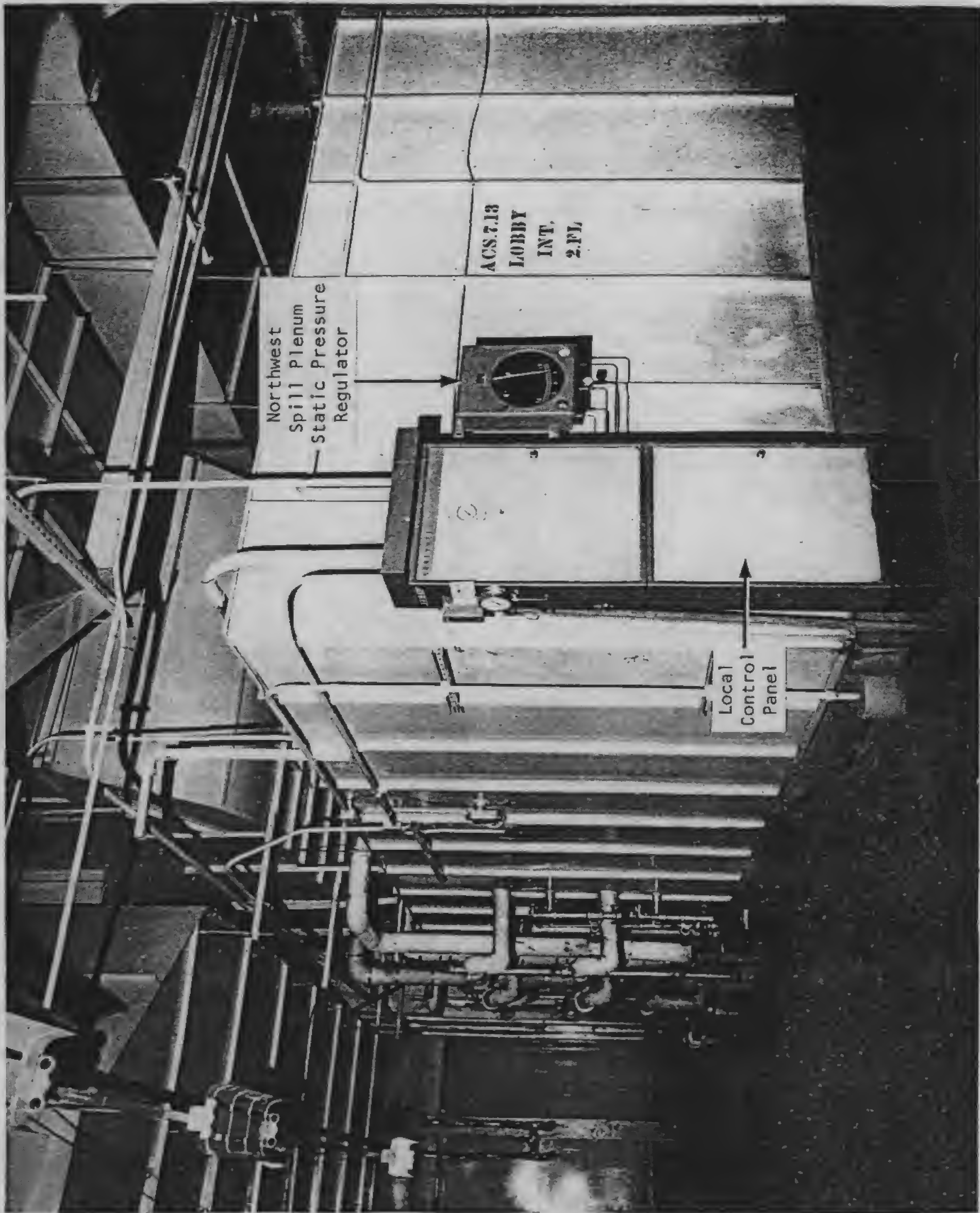


Figure 4.40 Second Floor Lobby HVAC Unit ACS 7-13
Left Side View

Figure 4.41 Control Diagram
Lobby Concourse Level HVAC Unit ACS 7-14

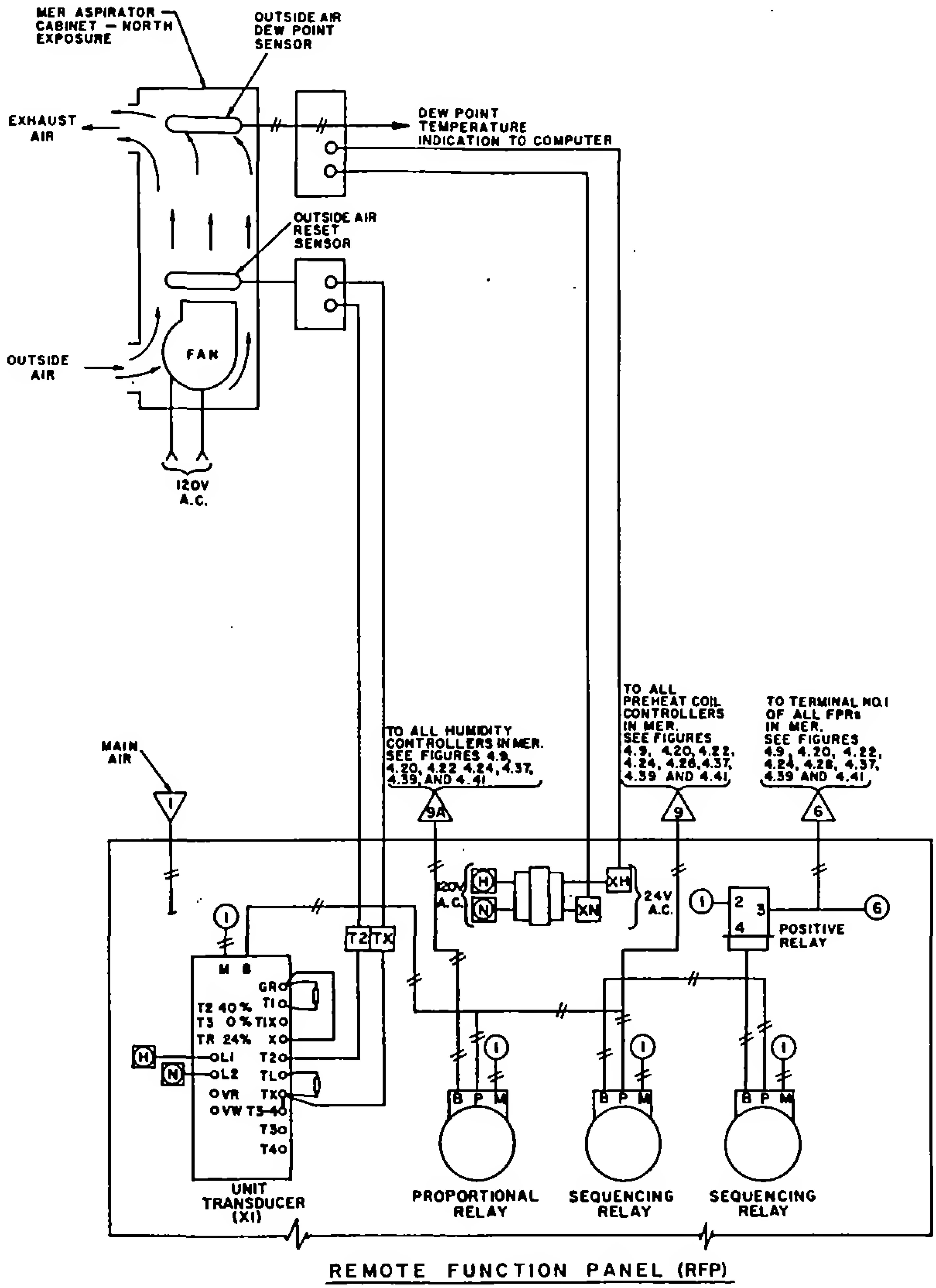


Figure 4.42 Schematic — Typical Master Outside Air Reset And Dew Point Temperature Indication Circuits

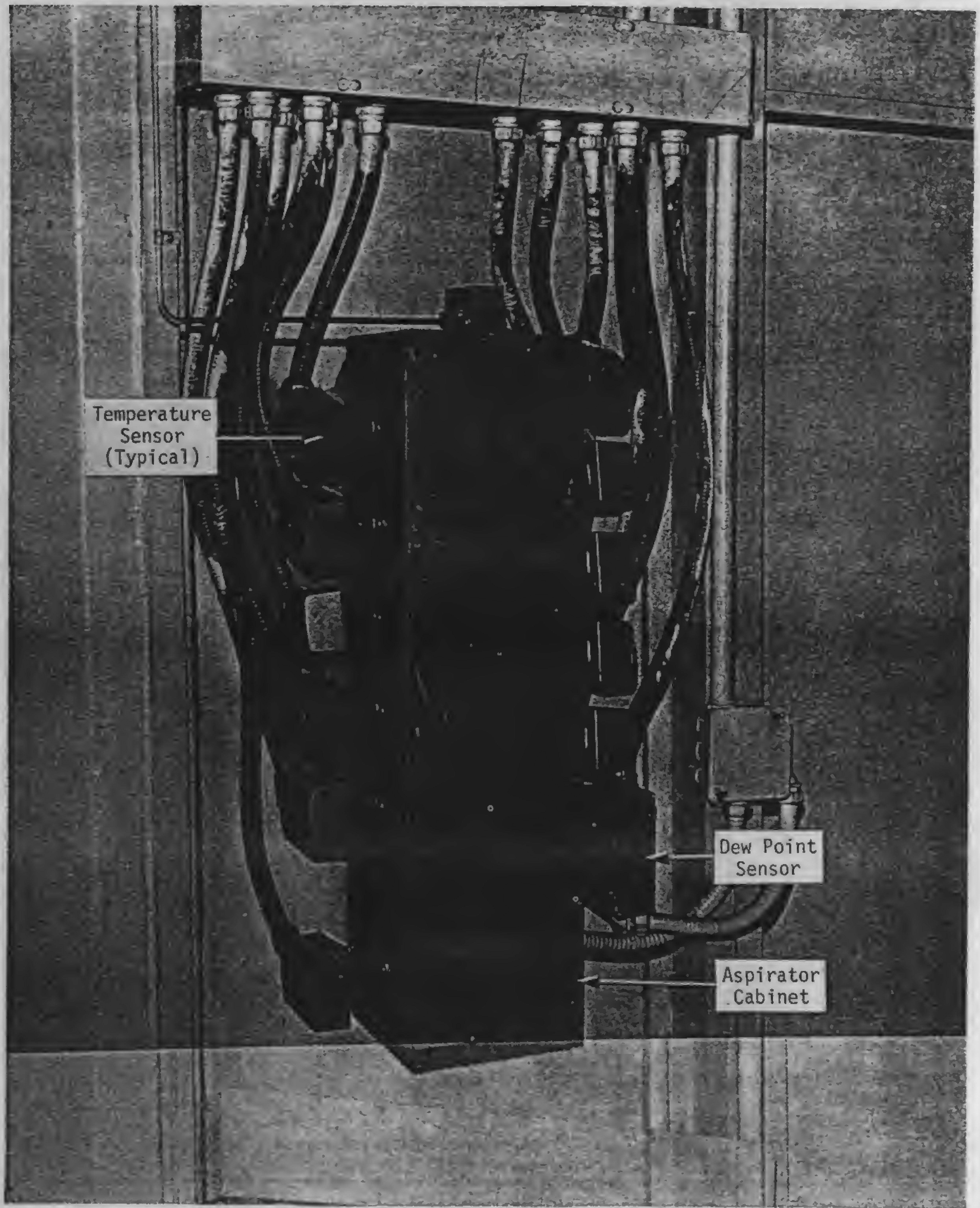


Figure 4.43 Typical MER Aspirator Cabinet

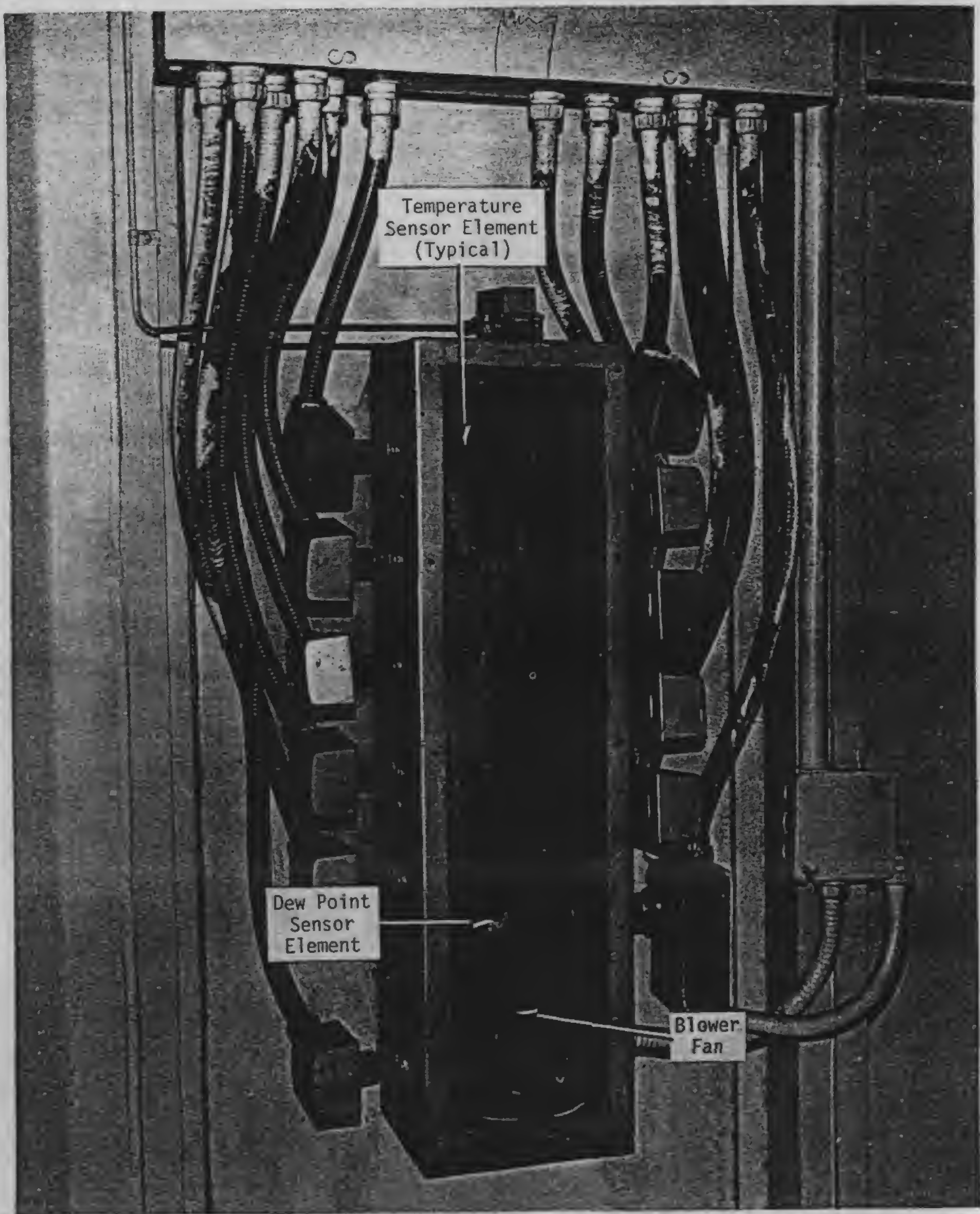


Figure 4.44 Typical MER Aspirator Cabinet
Interior View

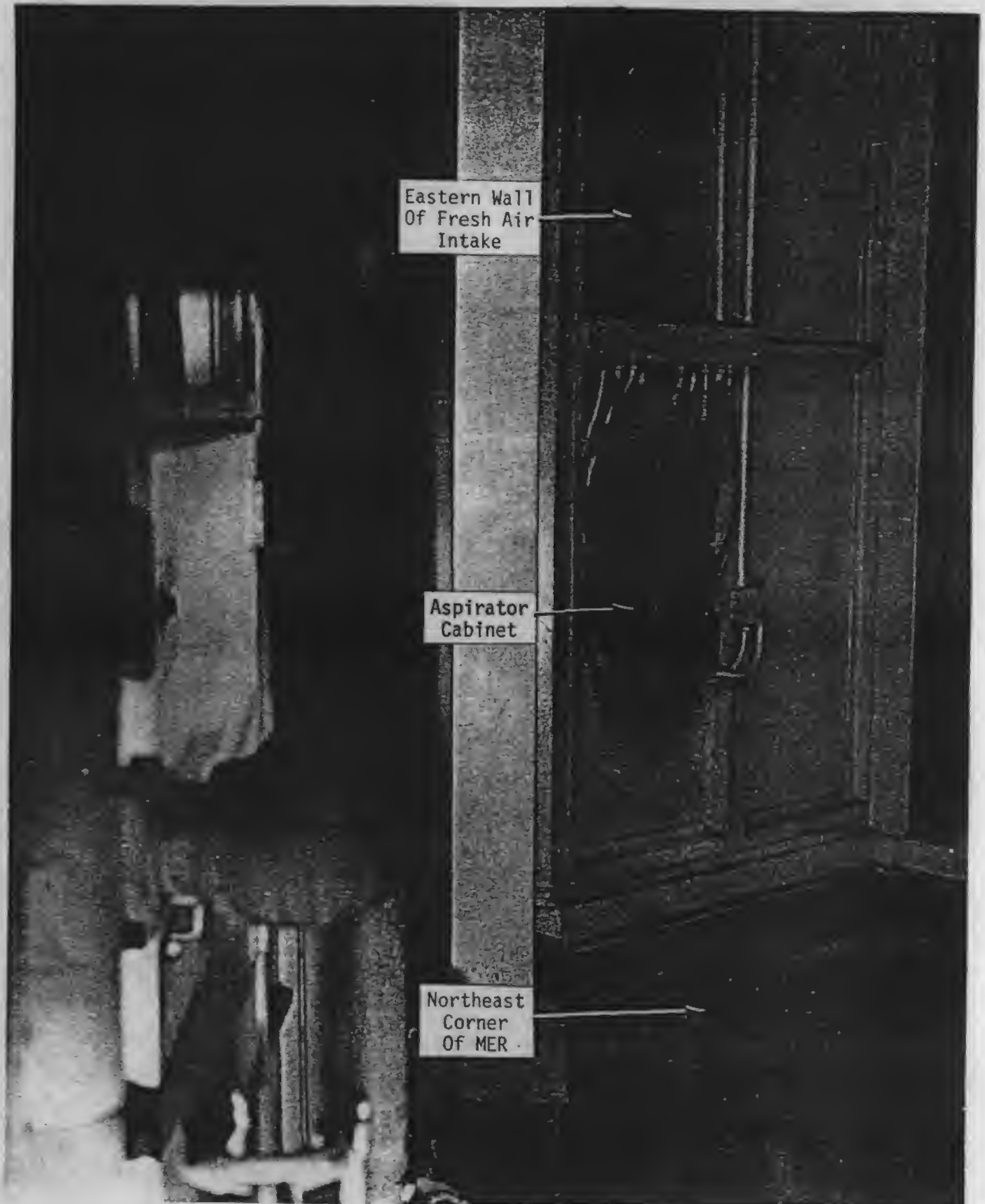


Figure 4.45 Location
Typical MER Aspirator Cabinet

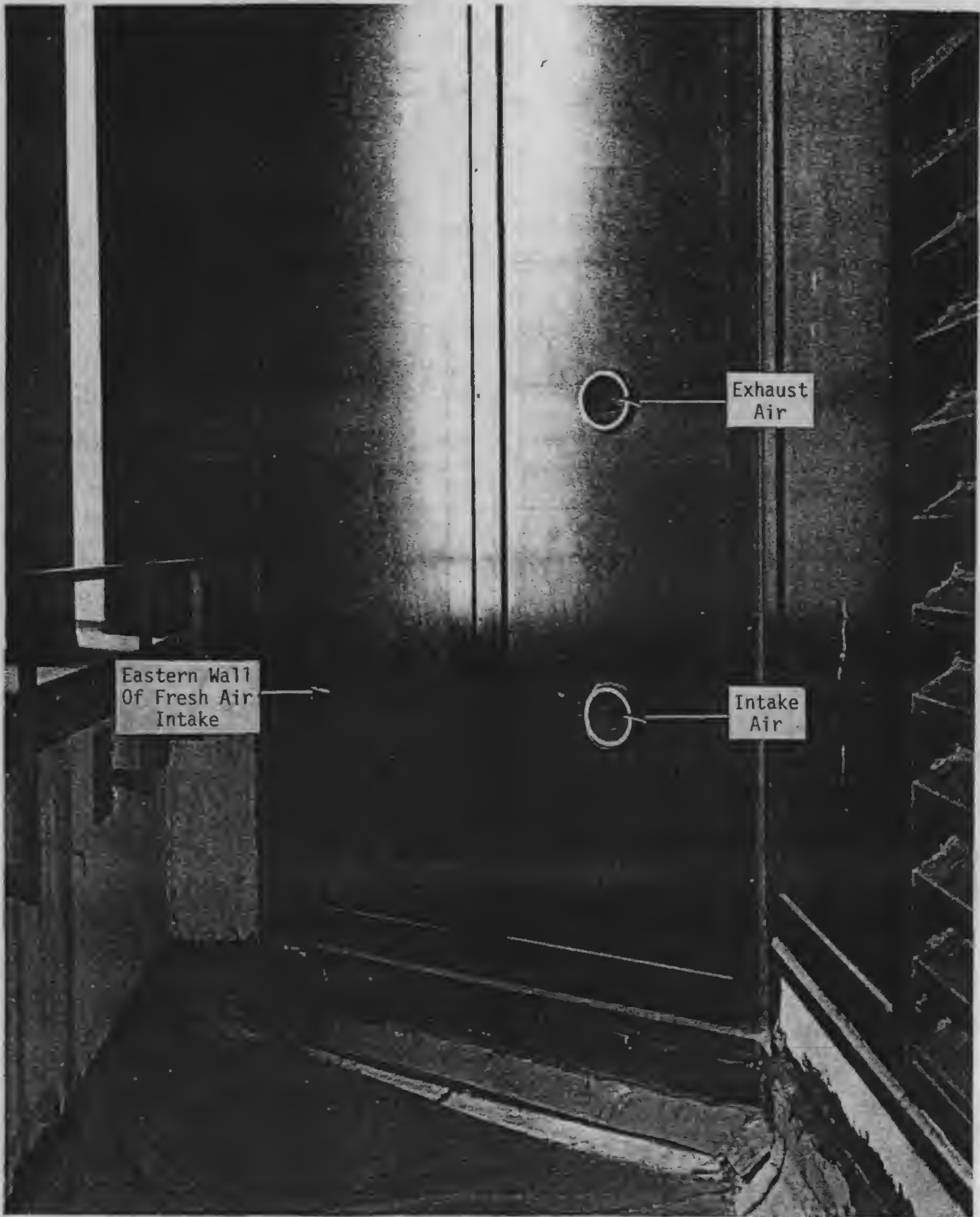


Figure 4.46 Intake And Exhaust Openings
Typical MER Aspirator Cabinet

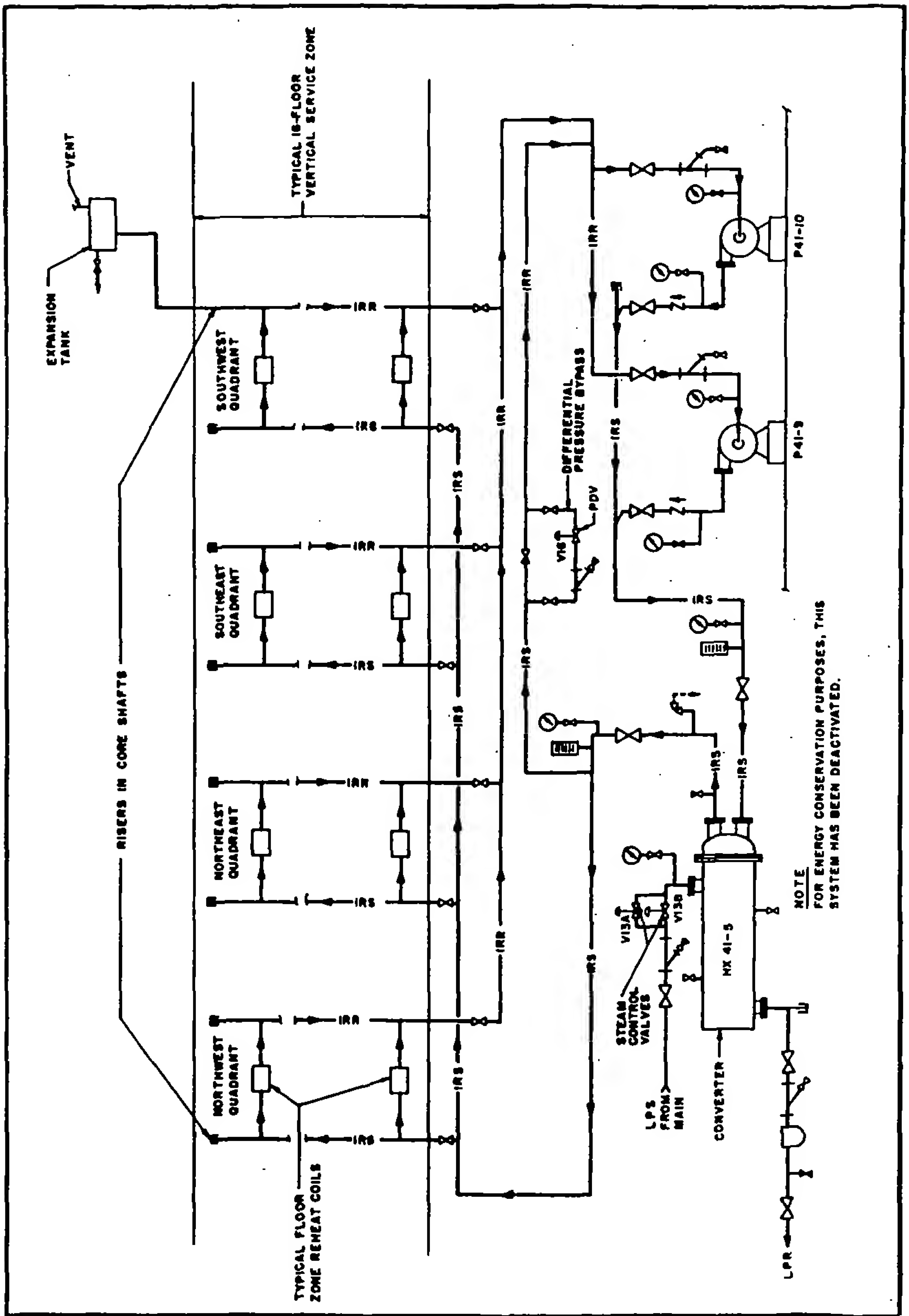


Figure 5.1 Flow Diagram
Interior Reheat Water System 41-5

Figure 5.2 Control Diagram
Interior Reheat Water System 41-5

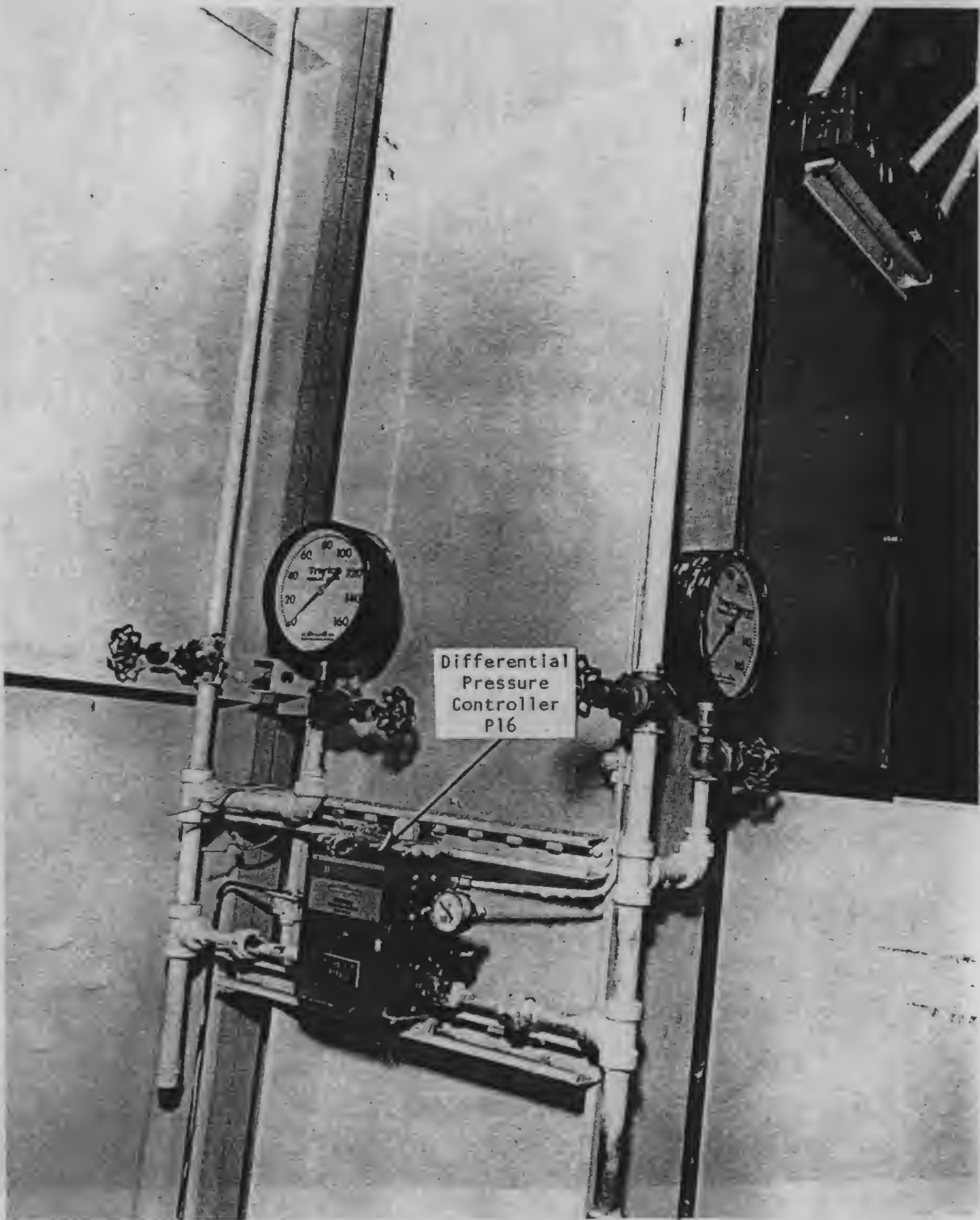


Figure 5.3 Typical Differential Pressure Controller
Interior Reheat Water System

Figure 5.4 Differential Pressure Bypass Piping
Interior Reheat Water System

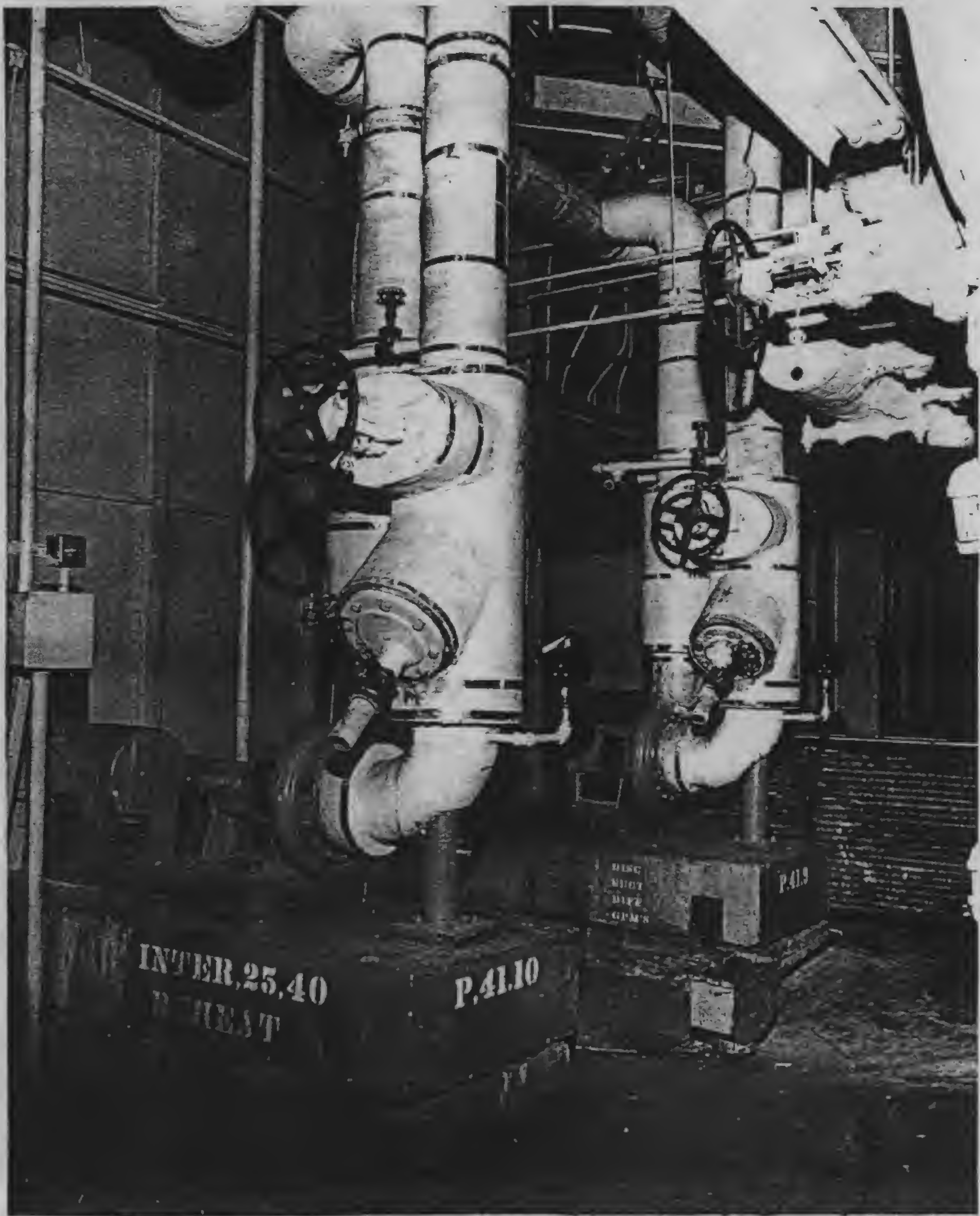


Figure 5.5 Typical Circulating Pumps
Interior Reheat Water System

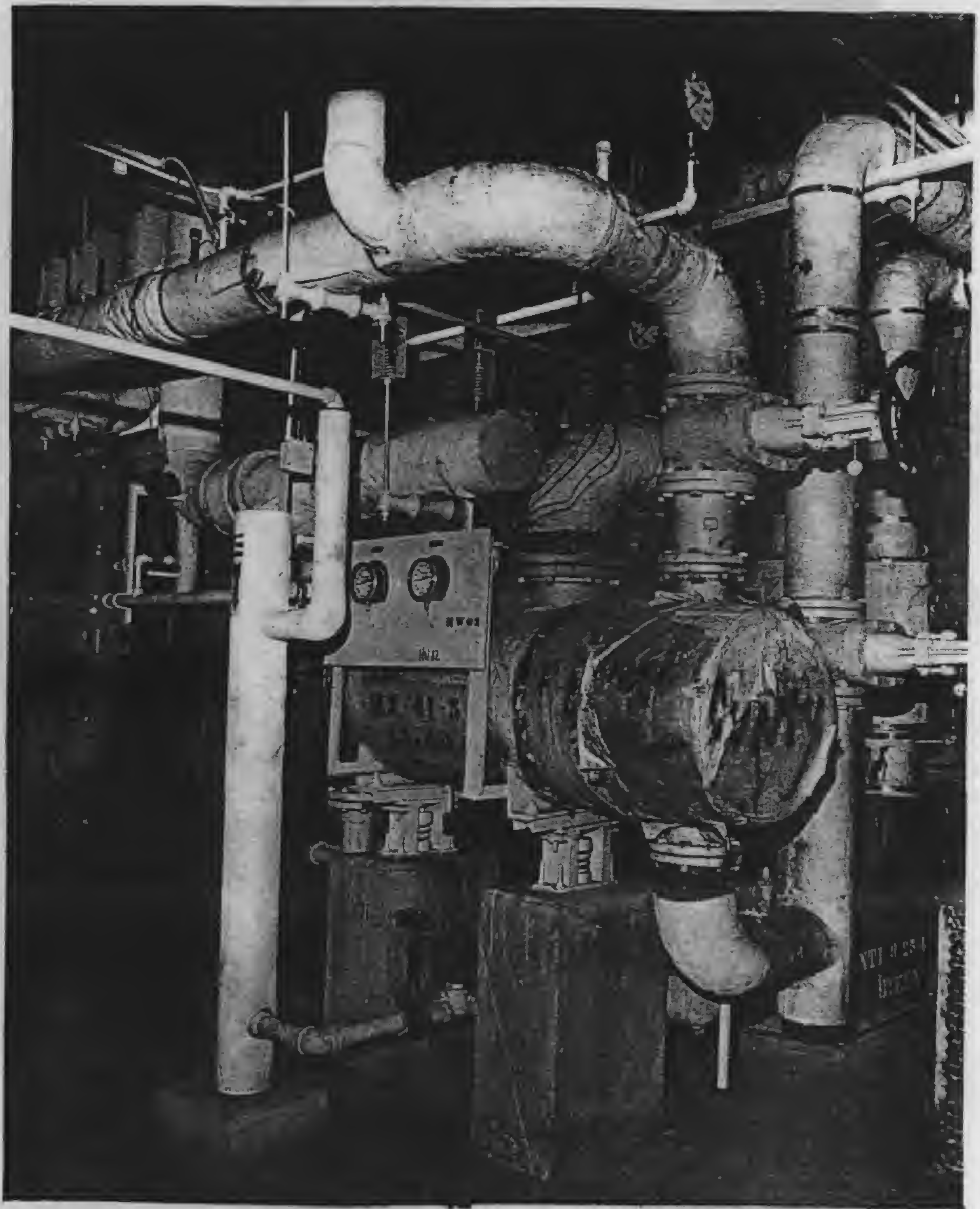


Figure 5.6 Typical Converter
Interior Reheat Water System

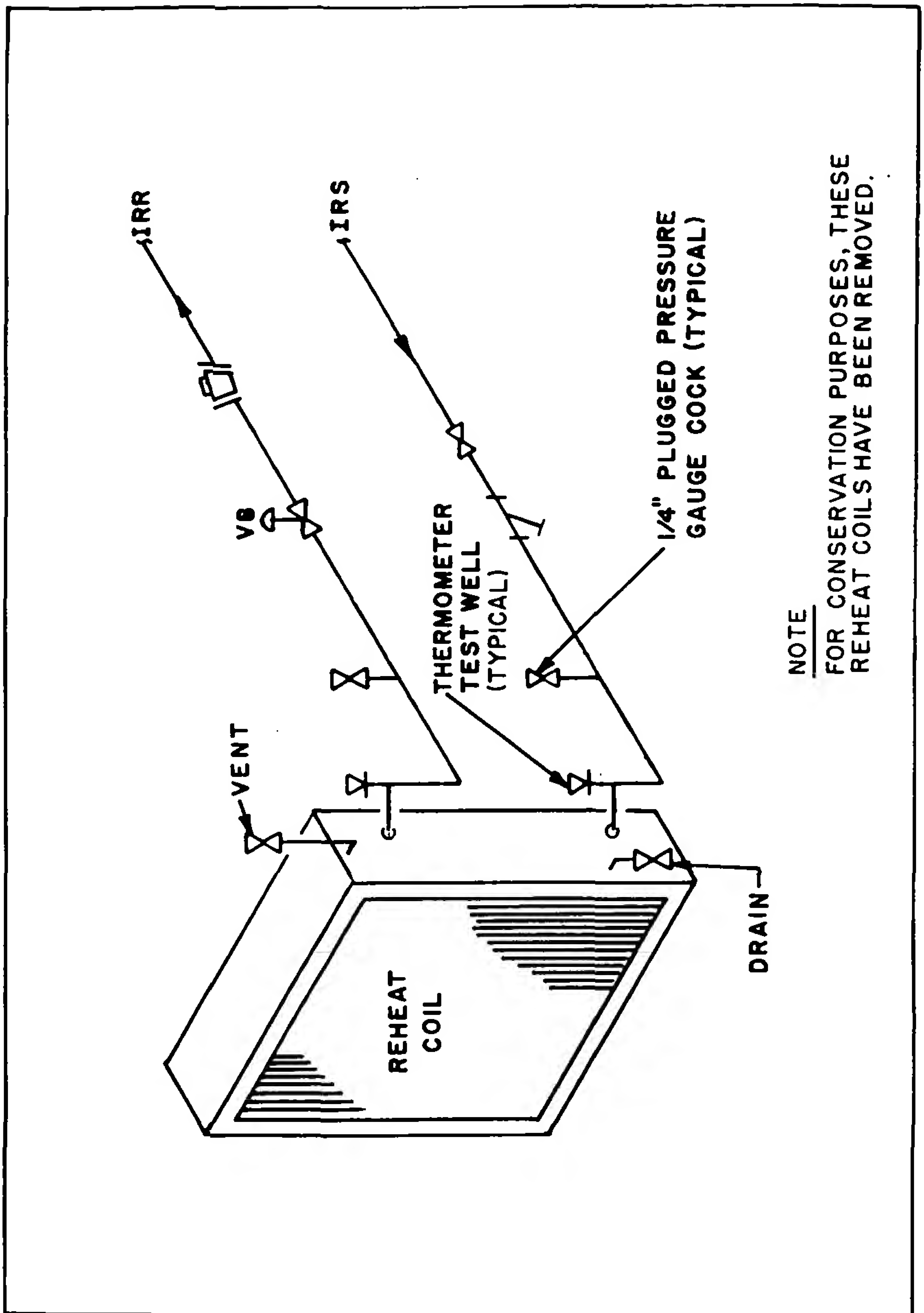


Figure 5.7 Schematic
Typical Duct-Mounted Interior Reheat Coil Piping

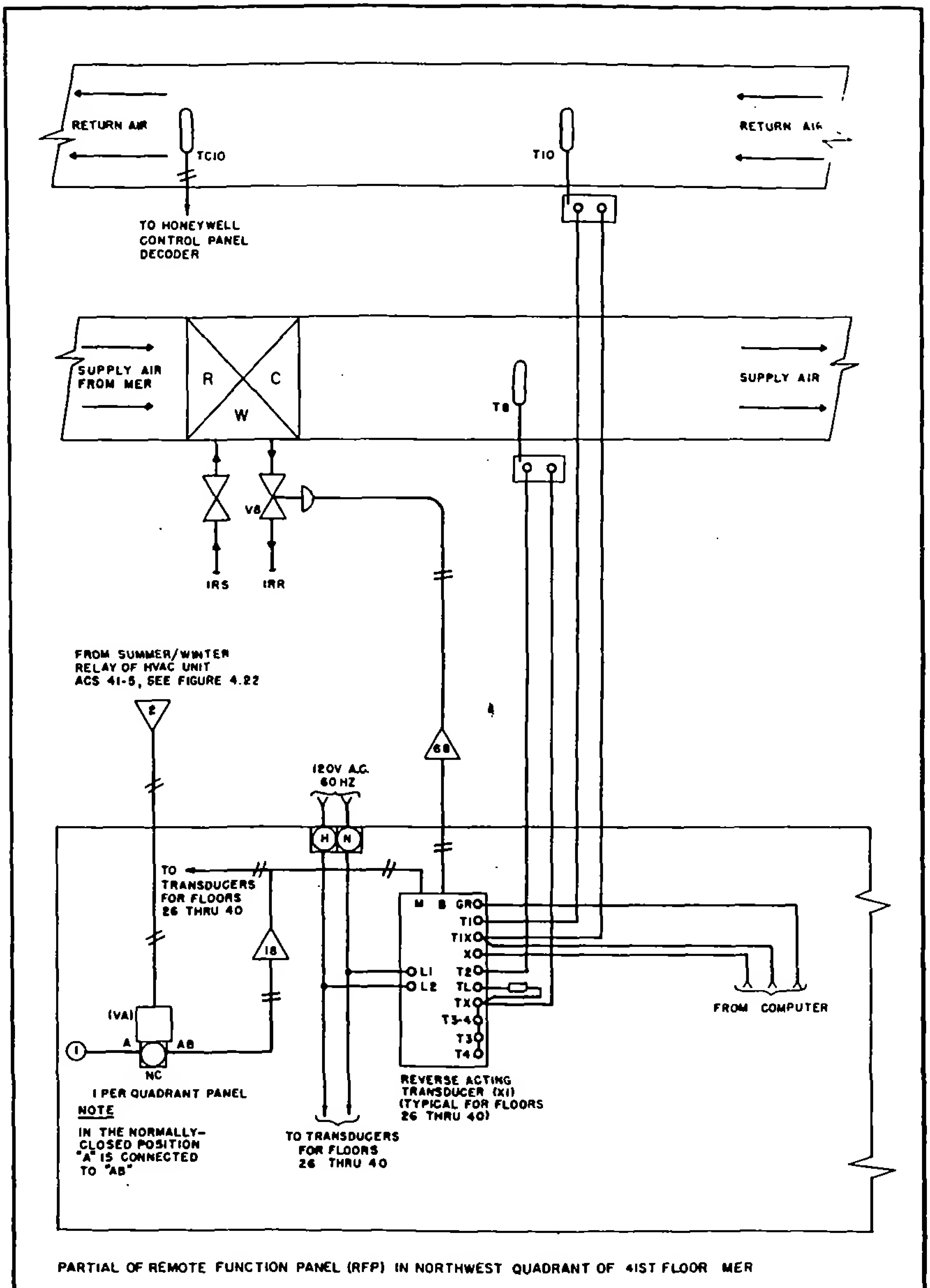


Figure 5.8 Control Diagram
Typical Interior Reheat Coil

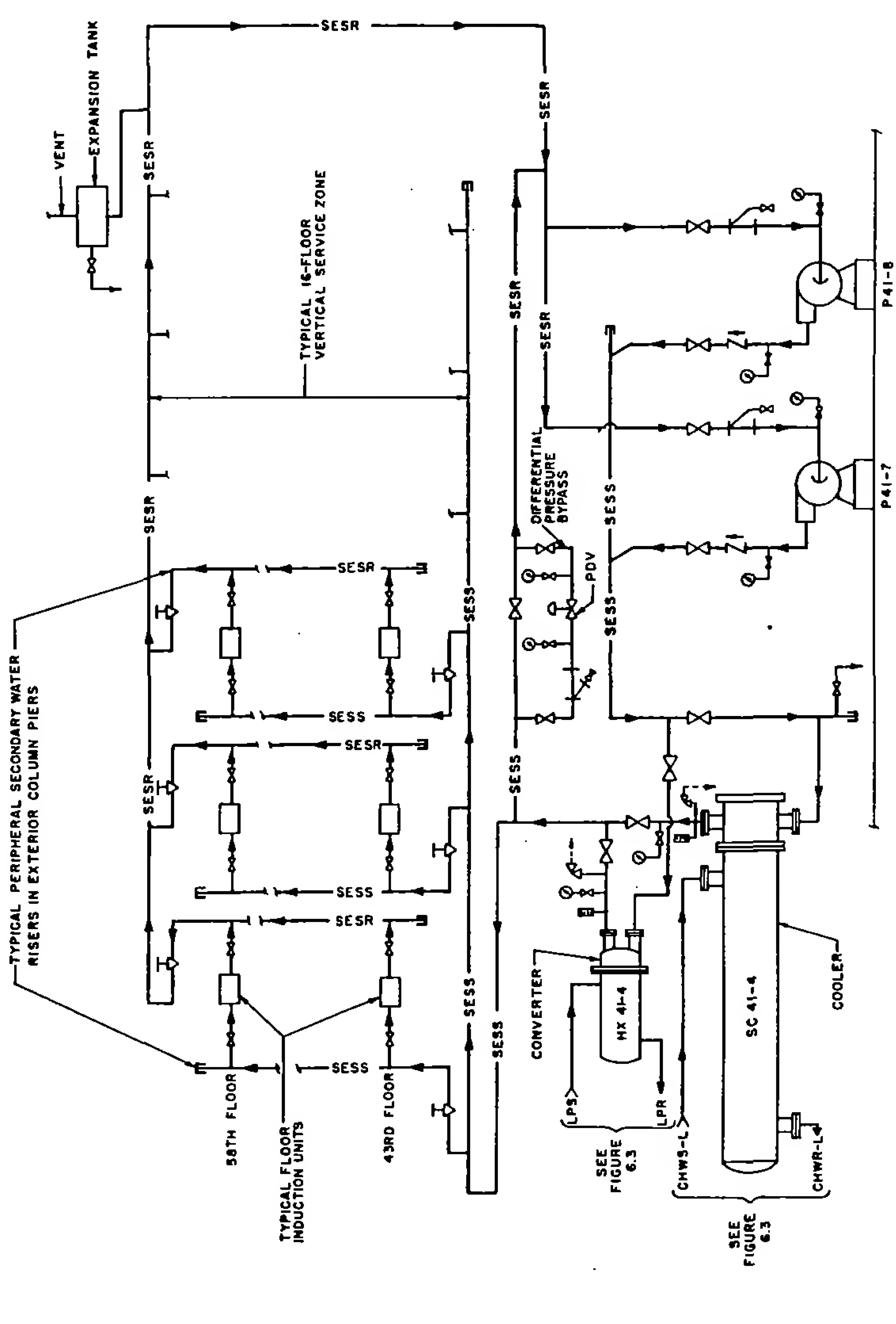


Figure 6.1 Flow Diagram
Secondary Water System 41-4

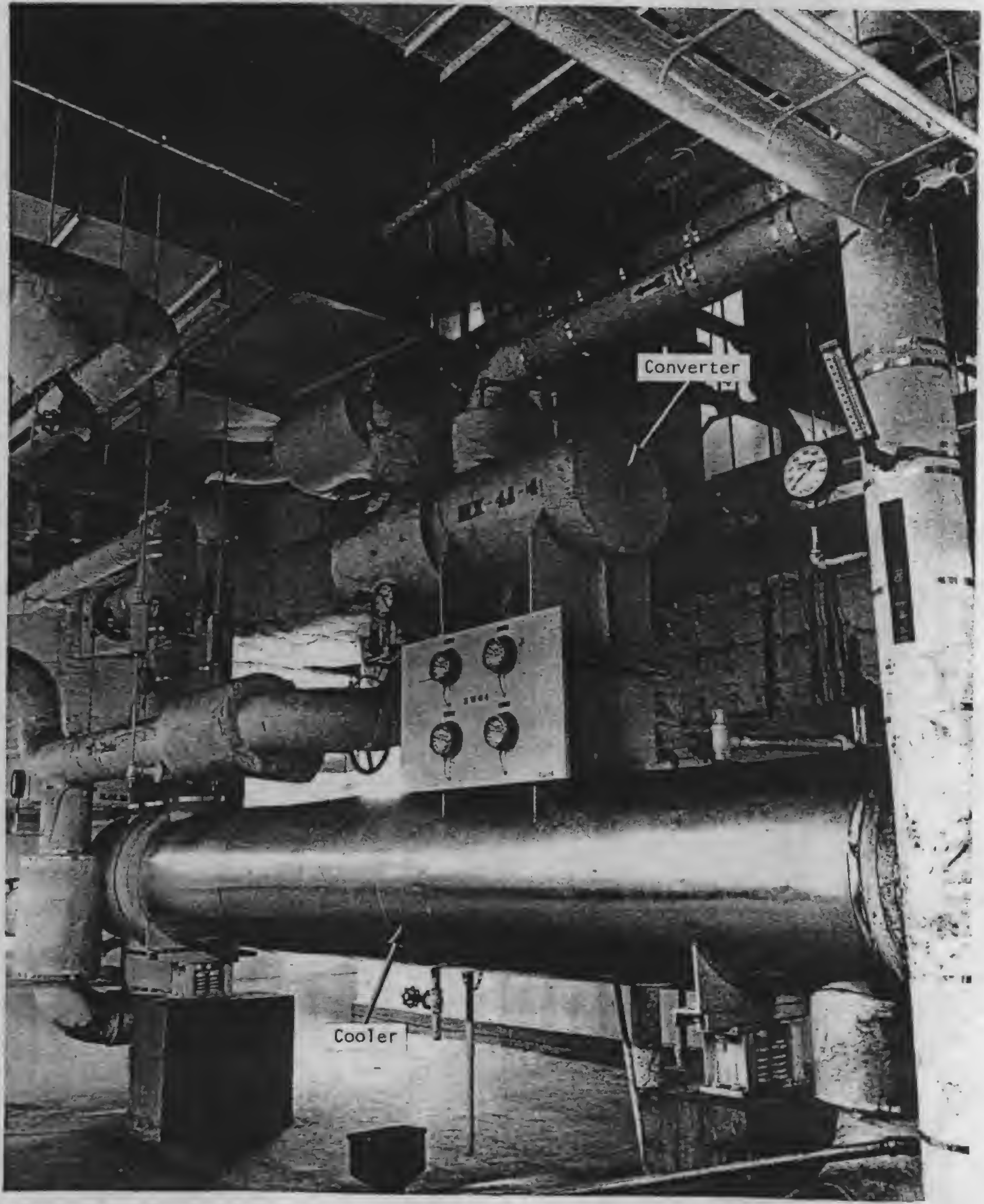


Figure 6.2 Typical Converter and Cooler
Secondary Water System

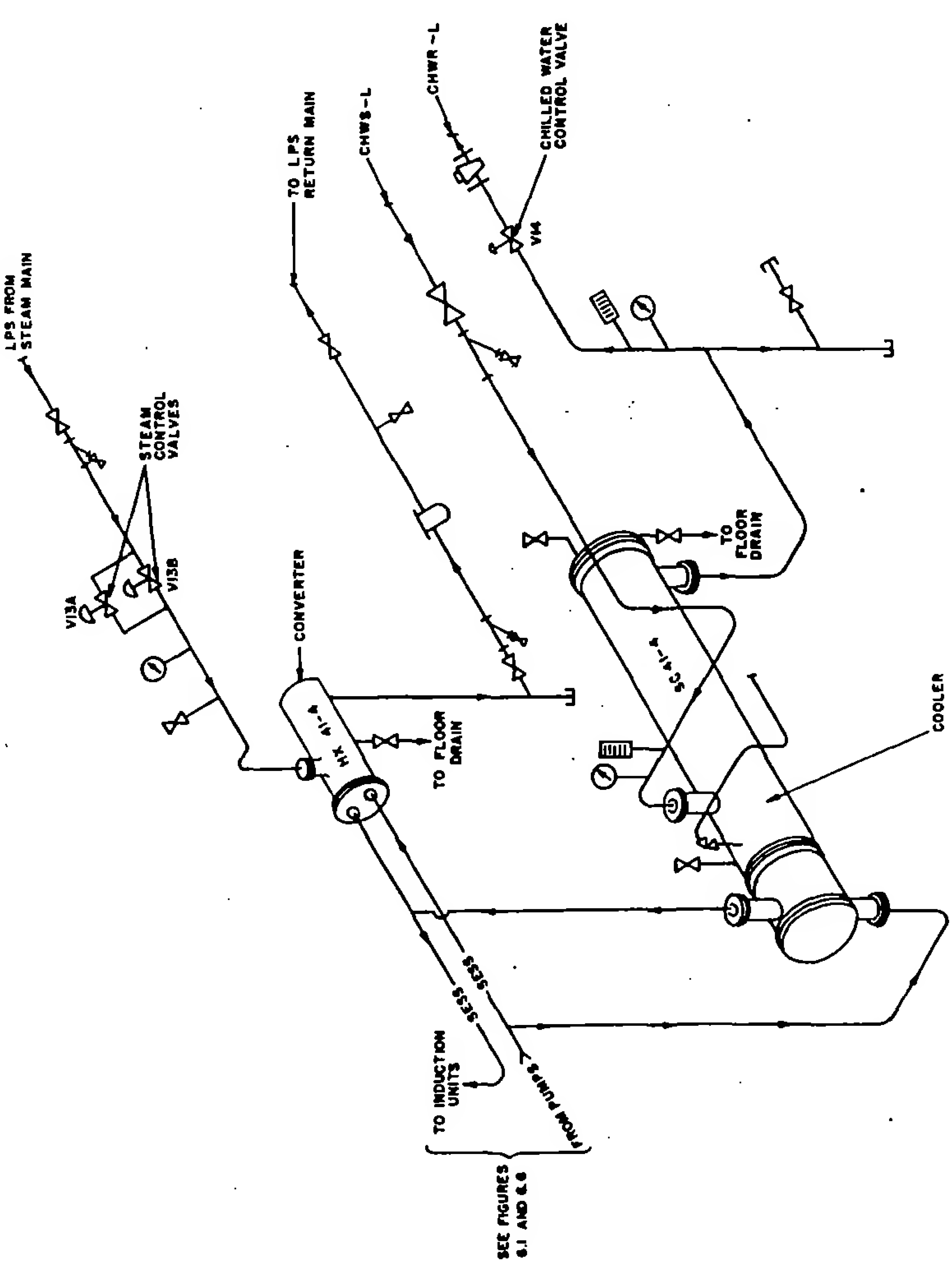


Figure 6.3 Schematic
Typical Converter And Cooler Piping - Secondary Water System

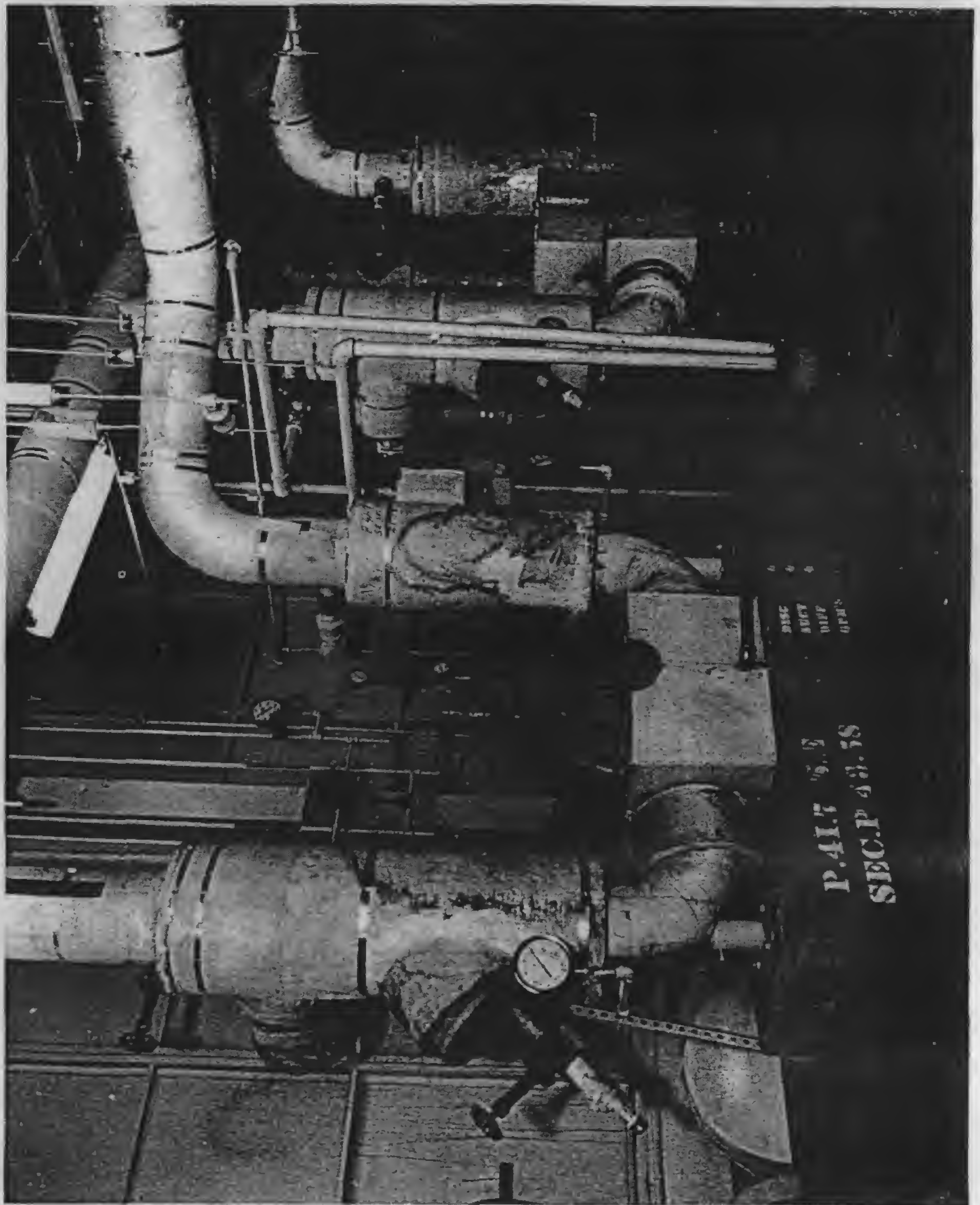


Figure 6.4 Typical Circulating Pumps
Secondary Water System

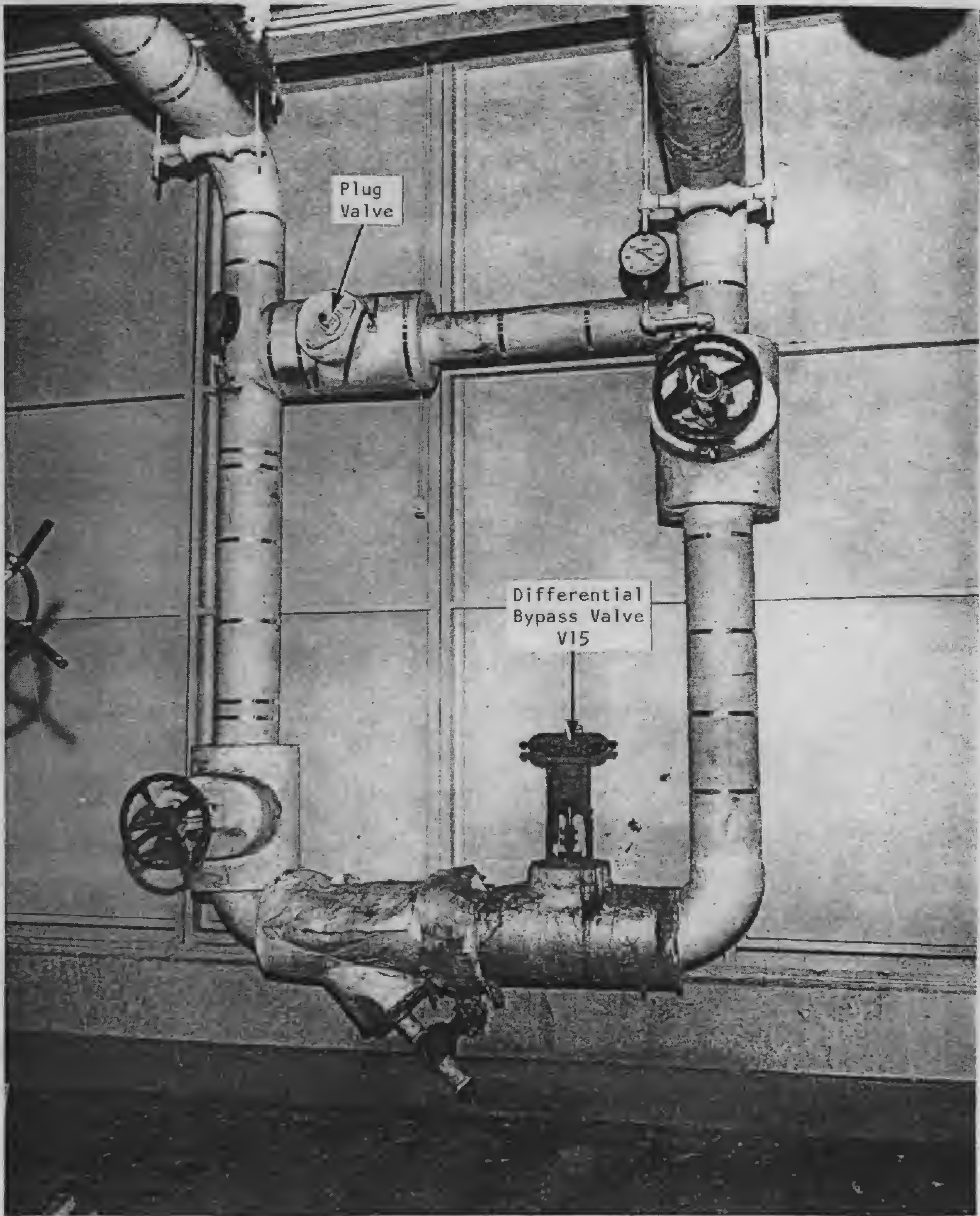


Figure 6.5 Typical Differential Pressure Bypass Secondary Water System

Figure 6.6 Control Diagram
Secondary Water System 41-4

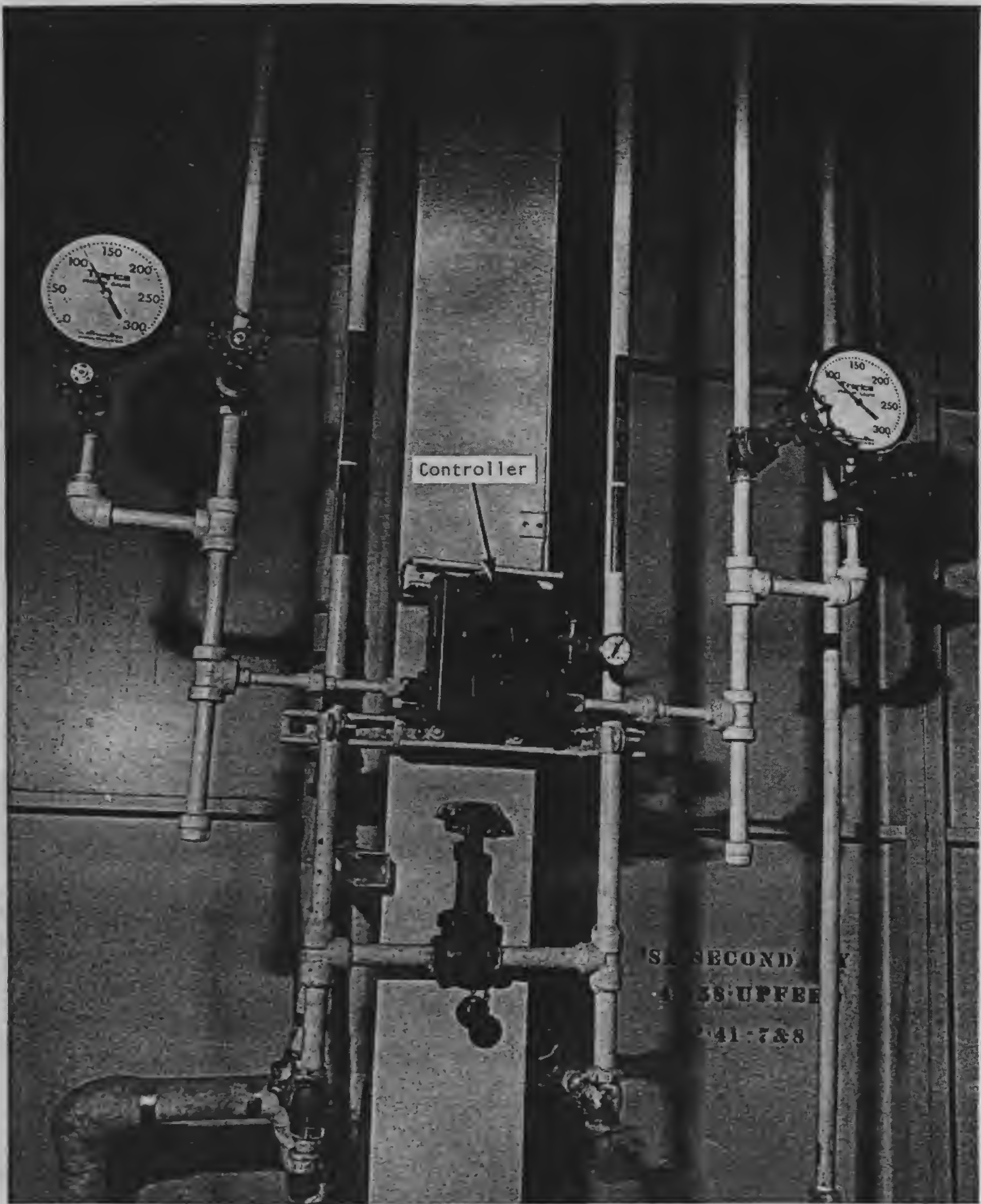


Figure 6.7 Typical Differential Pressure Controller
Secondary Water System

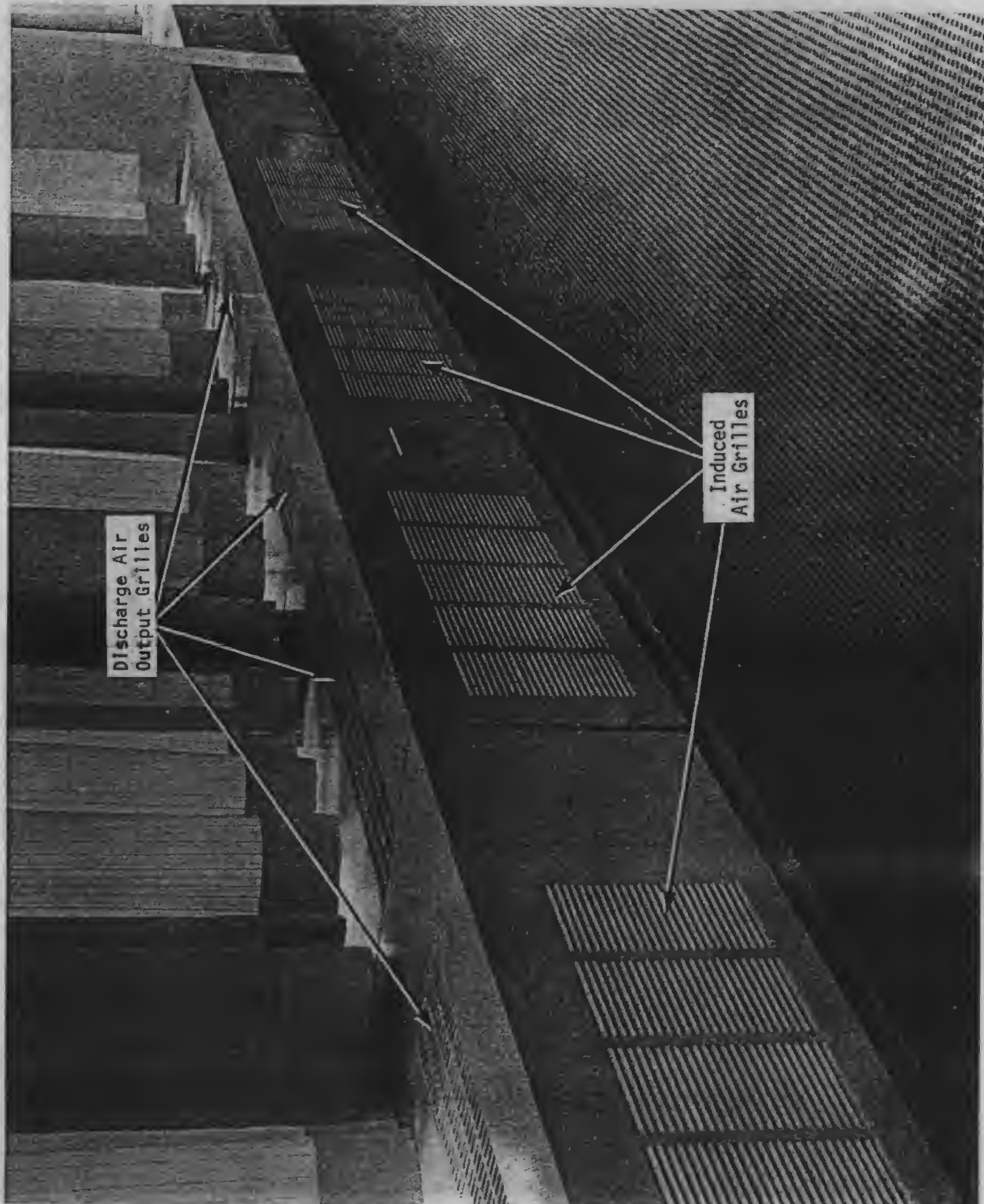


Figure 6.8 Typical Induction Units
Peripheral Air Conditioning

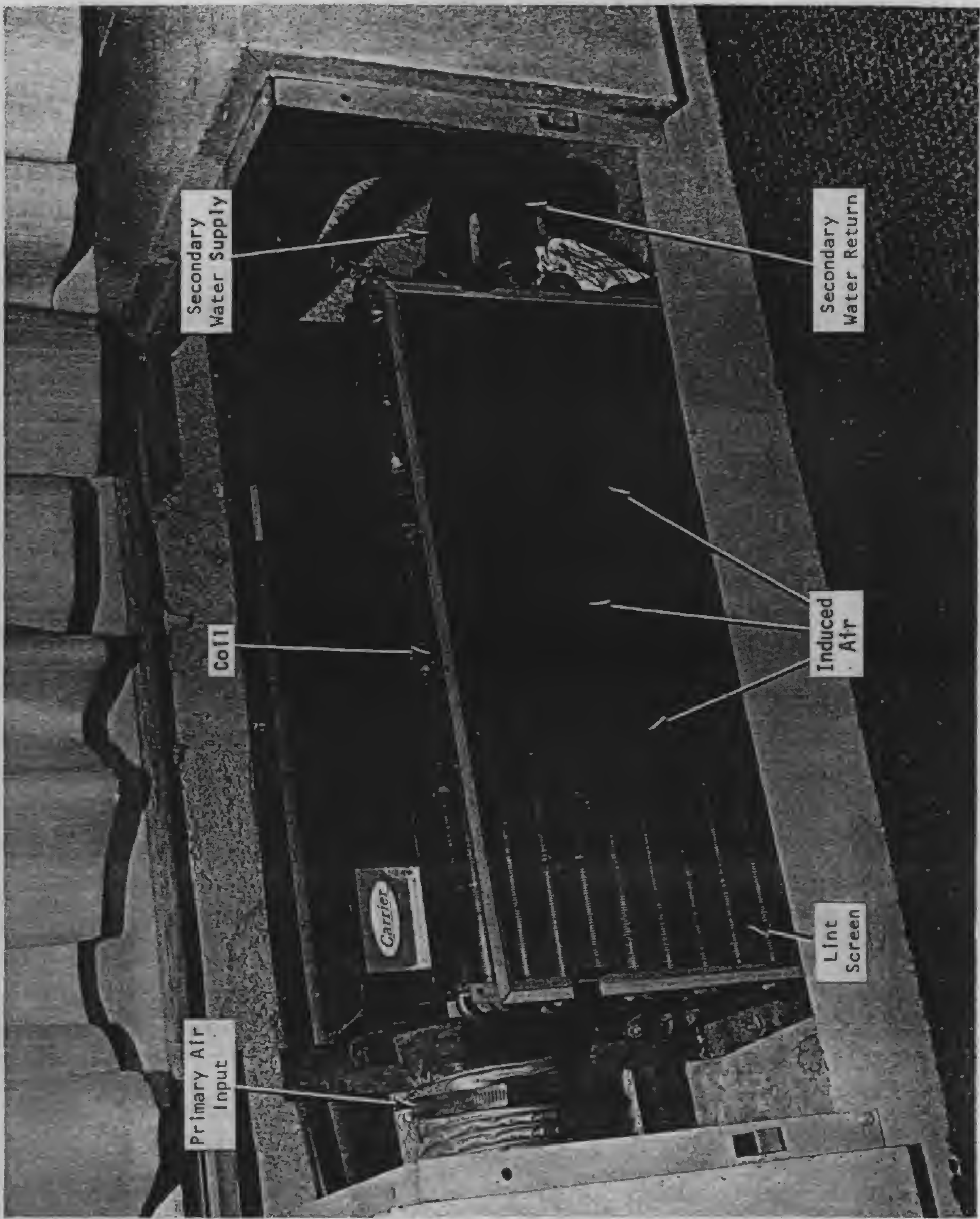


Figure 6.9 Typical Induction Unit Interior View

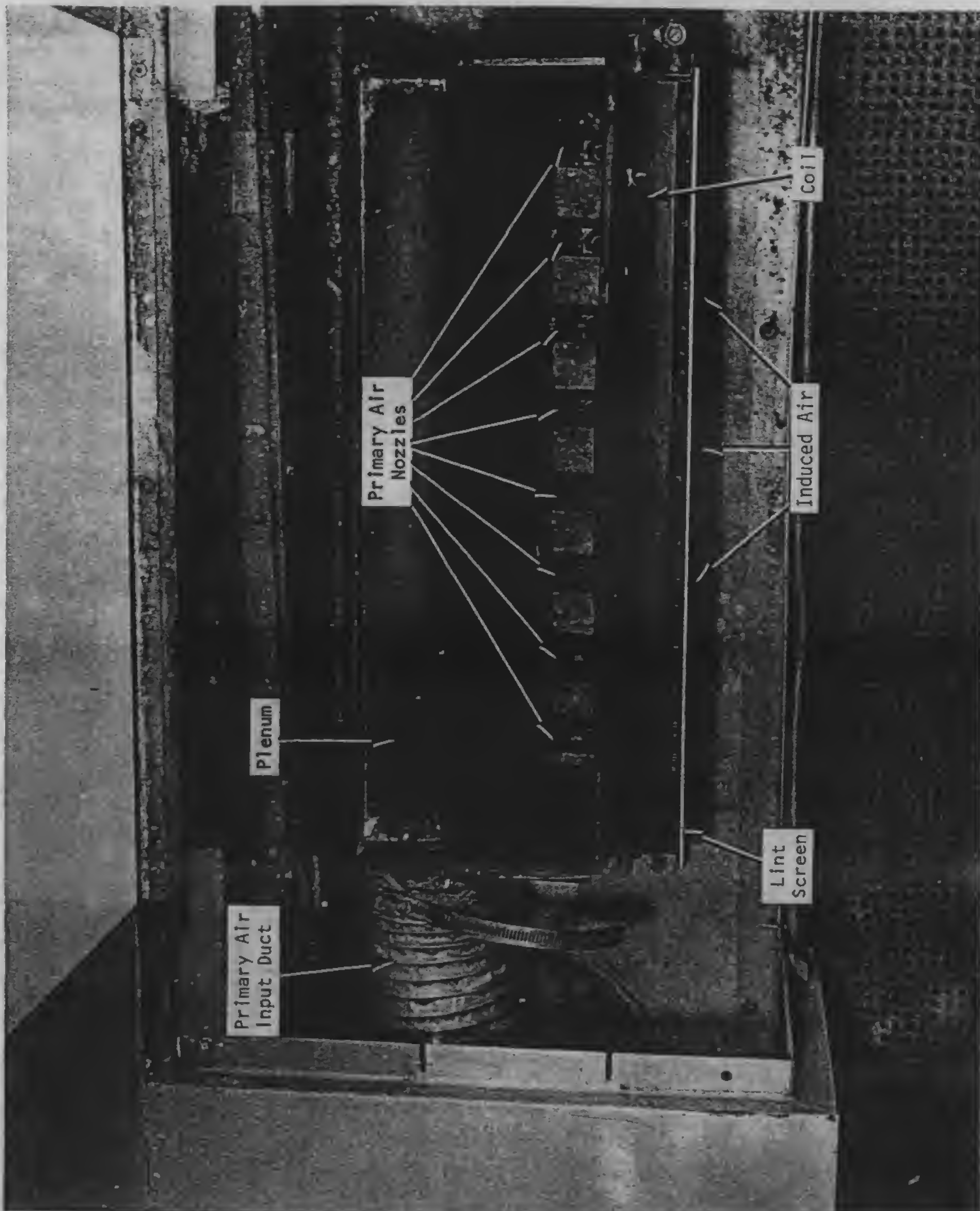


Figure 6.10 Typical Induction Unit
Top Interior View

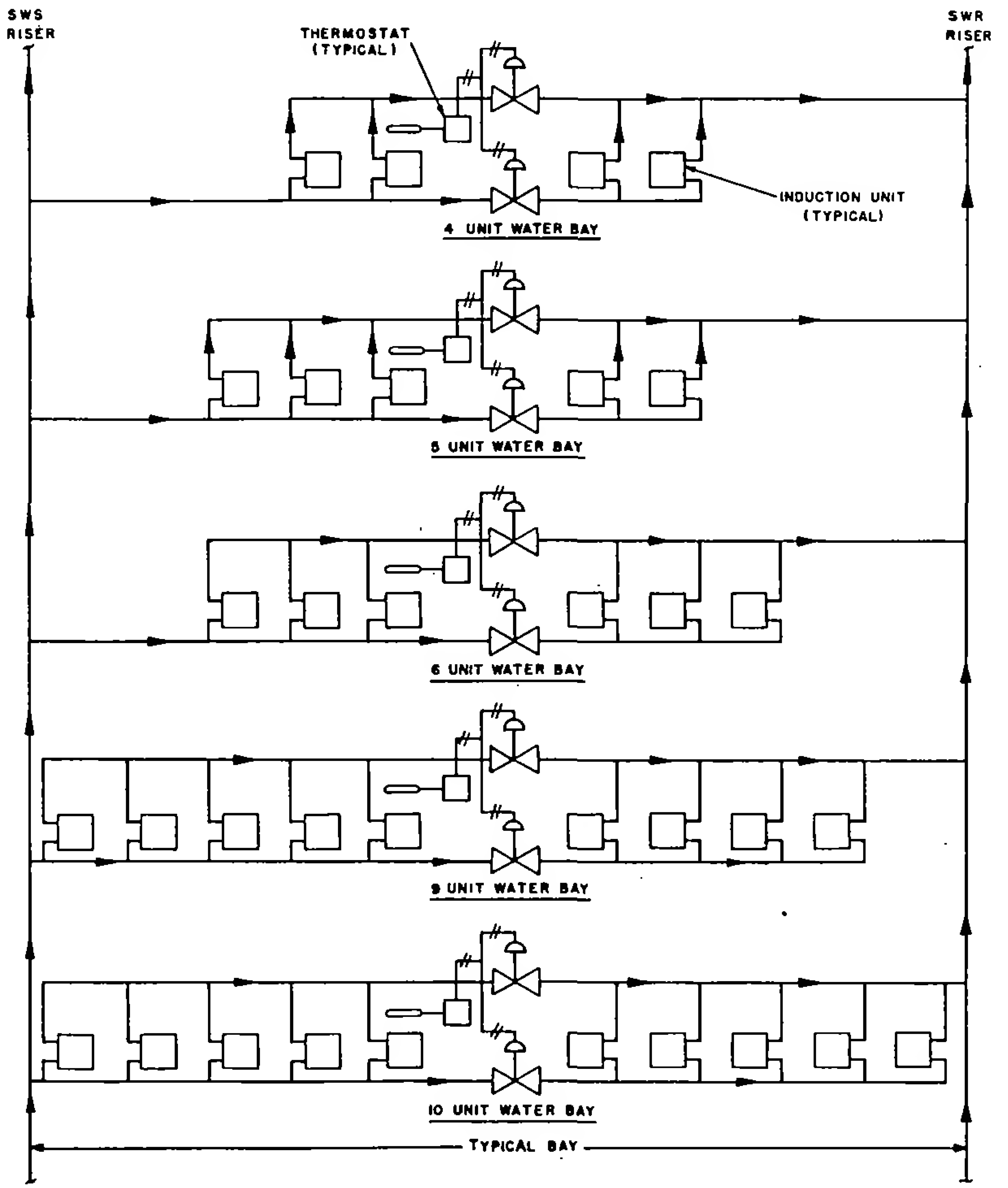


Figure 6.11 Control Diagram Induction Units

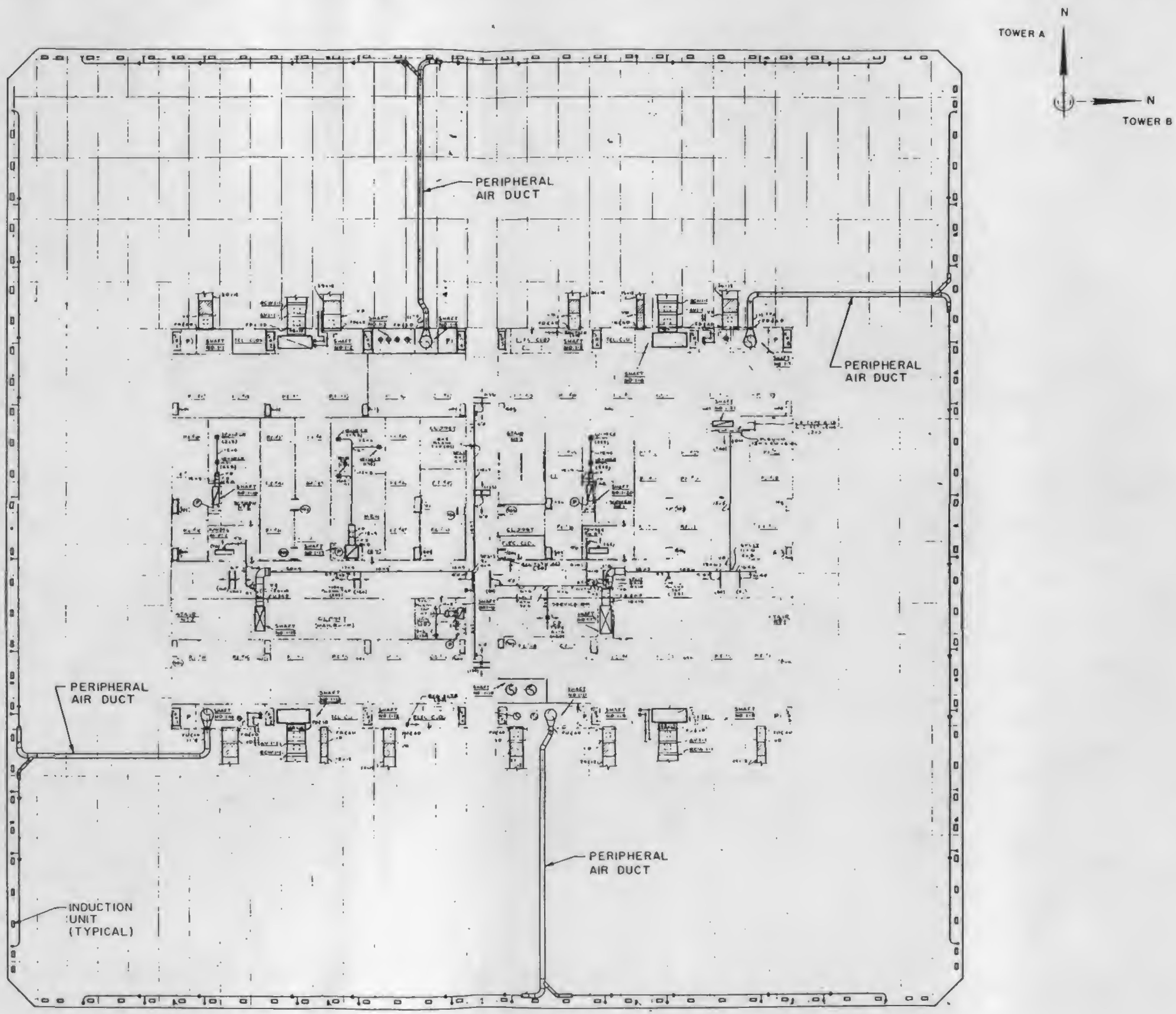


Figure 7.2 Typical Duct Layout
Peripheral Air Distribution — Tenant Floors

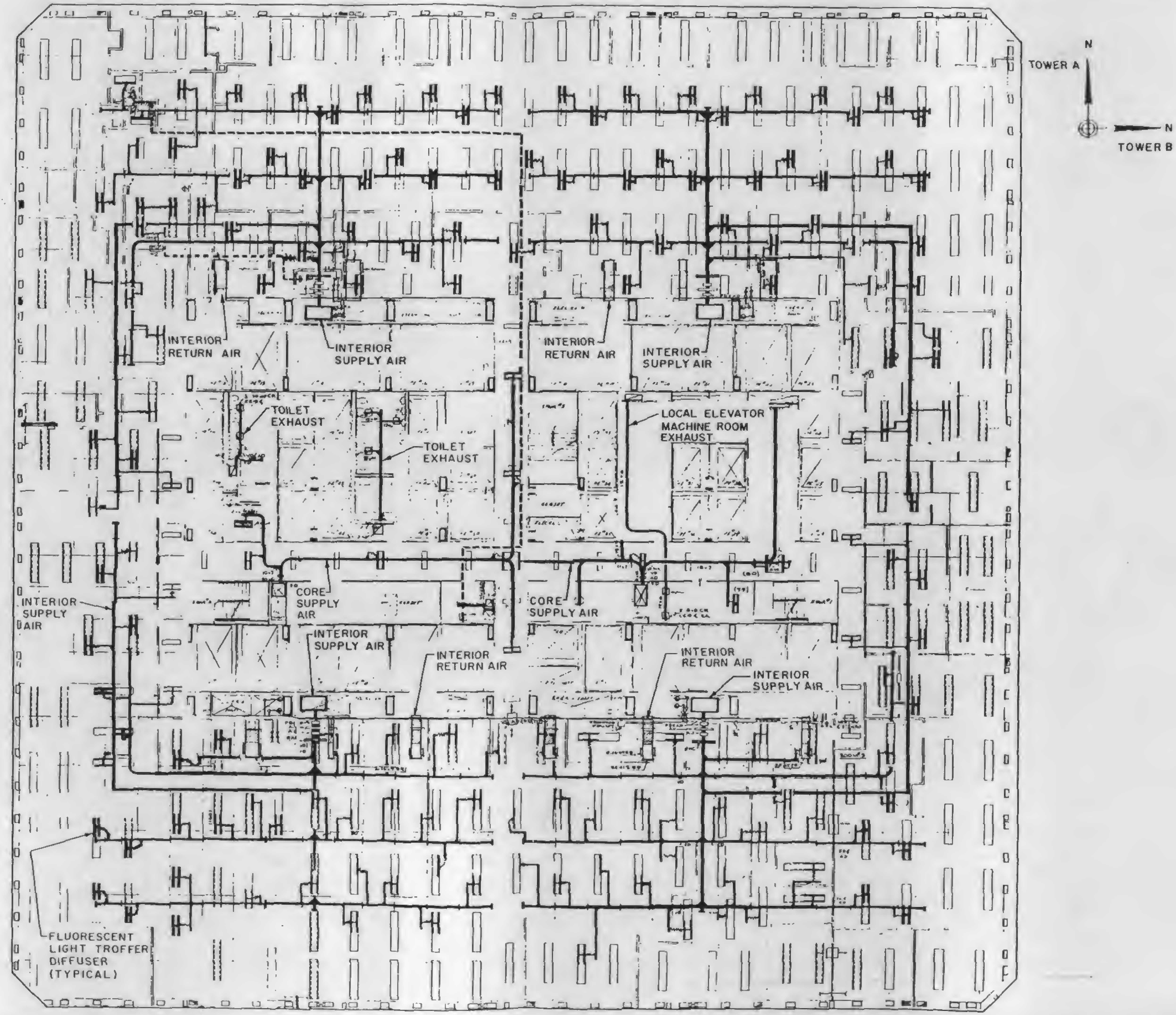


Figure 7.1 Typical Duct Layout
Core and Interior Air Distribution – Tenant Floors

Symbol	*Description*
A.C.	Alternating Current
ACR	Air Conditioning Return
ACS	Air Conditioning Supply
C	Pneumatic Controller
CAR	Control Air Failure Shutdown Relay
CC	Cooling Coil
CD	Cool Down
CHW	Chilled Water
CHWR-H	Chilled Water Return - High Zone
CHWR-L	Chilled Water Return - Low Zone
CHWS	Chilled Water Supply
CHWS-H	Chilled Water Supply - High Zone
CHWS-L	Chilled Water Supply - Low Zone
CP	Control Pilot
CPA	Control Point Adjustment
DC	Direct Current
DCW	Domestic Cold Water
D1A	Minimum Outside Air Damper
D1B	Maximum Outside Air Damper
D7	Discharge Air Damper
D10	Return Air Damper
DP10	Spill Air Damper
DP11	Main Spill Air Damper
DPS	Dewpoint Sensor
DS	Damper Switch
DV7	Vortex Damper
ELEV.	Elevation

Symbol	*Description*
EMR	Elevator Machine Room
EP	Electro-Pneumatic
ER	Electric Relay
ES	Electric Switch
F.	Fahrenheit
FP	Cooling Coil Freeze Protection Pump
FPCS	Freeze Pump Control Switch
FPR	Freeze Protection Pump Control Relay
FS	Flow Switch
GPM	Gallons Per Minute
HPS	High Pressure Steam
HT	High Temperature Thermostat (Firestat)
HVAC	Heating, Ventilating, and Air Conditioning
HX	Heat Exchanger
INT.	Interior
IRR	Interior Reheat Hot Water Return
IRRS	Interior Reheat Hot Water Reversed Supply
IRS	Interior Reheat Hot Water Supply
IS	Interior Supply
LCP	Local Control Panel
LPR	Low Pressure Return
LPS	Low Pressure Steam
LT	Low Temperature Thermostat (Freezestat)
M1A	Minimum Outside Air Damper Motor
M1B	Maximum Outside Air Damper Motor

Symbol	*Description*
M7	Discharge Air Damper Motor
M10	Return Air Damper Motor
MCC	Motor Control Center
MER	Mechanical Equipment Room
MPS	Medium Pressure Steam
MP10	Spill Air Damper Motor
MP11	Main Spill Air Damper Motor
MV7	Vortex Damper Motor
NC	Normally Closed
NO	Normally Open
O&M	Operation and Maintenance
P	Pump
PDV	Pressure Differential Valve
PE	Pneumatic-Electric
PHC	Preheat Coil
PRV	Pressure Reducing Valve
PS	Pressure Switch
PSI	Pounds Per Square Inch
PSIG	Pounds Per Square Inch, Gage
R	Relay
R.A.	Reverse Acting
RCS	Steam Reheat Coil (Duct Mounted)
RCW	Hot Water Reheat Coil (Duct Mounted)
RFP	Remote Function Panel
RHC	Reheat Coil
SC	Secondary Water Cooler
SESR	South and East Zone Secondary Water Return

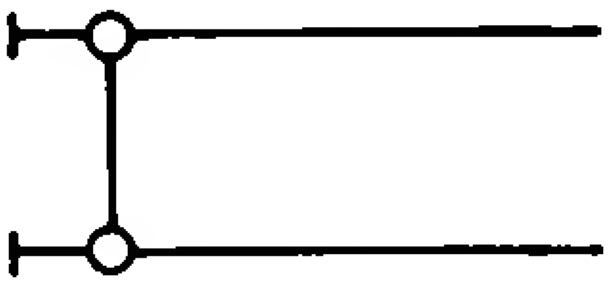
Symbol	*Description*
SESS	South and East Zone Secondary Water Supply
SR	Selector Relay
S/S	Start/Stop
SWR	Secondary Water Return
SWS	Secondary Water Supply
T	Temperature Sensor (Temperature to Electric)
TC	Thermocouple (Temperature to Electric)
TD	Time Delay Relay
TS	Temperature Sensor (Temperature to Air)
TWR	Tower
V	Valve
VP	Chilled Water Coil Freeze Protector Valve
WTC	World Trade Center
WU	Warm Up
X	Transducer
XA	Transducer Alarm Relay

Pipe Cap or Plug

High or Low Pressure Steam

Pneumatic Control Tubing

Chilled Water

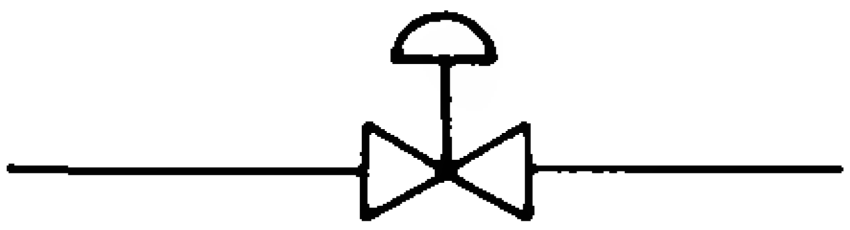


Gauge Glass

Relief Valve

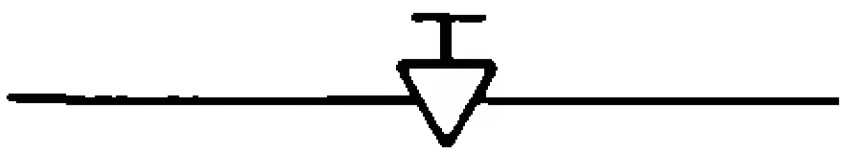
Check Valve (Arrow Indicates Direction of Flow)

Plug Valve or Stop Cock



Diaphragm-Operated Automatic Control Valve

Hand-Operated Globe or Gate Valve



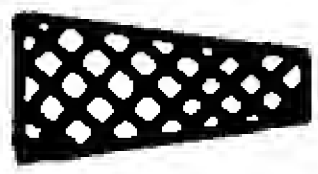
Needle Valve

Thermometer

Floor Drain

Pressure or Temperature Gauge

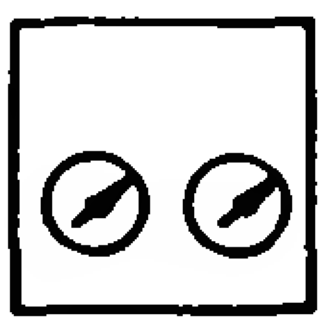
Thermal Monitoring Element



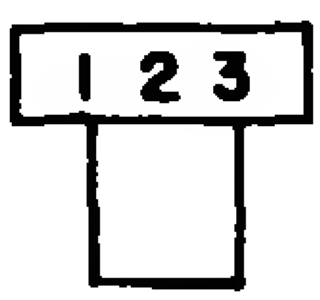
Sound Diffractor

Steam Trap

Strainer with Blow Off

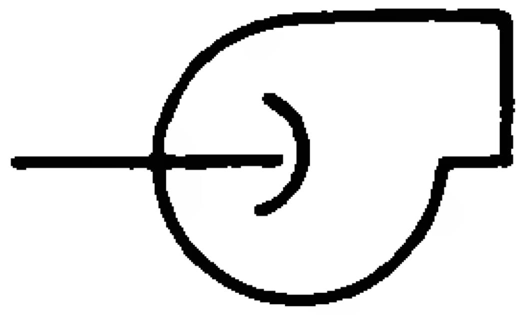


Control Pilot

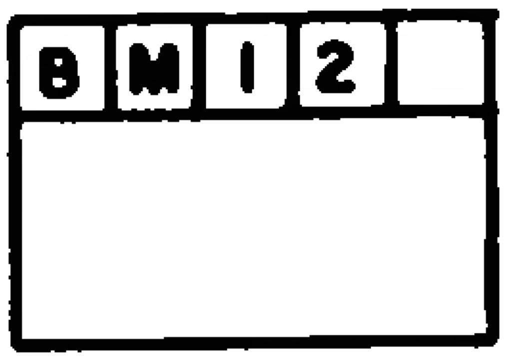


Electric-Pneumatic Relay

Main Control Air

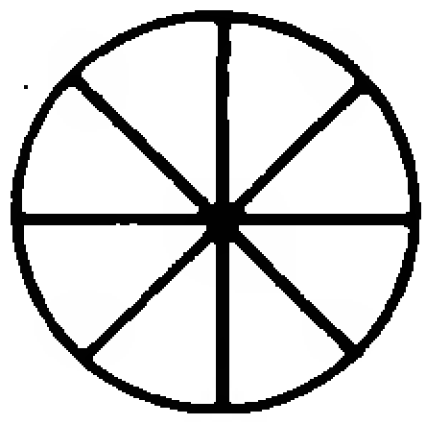


Pump

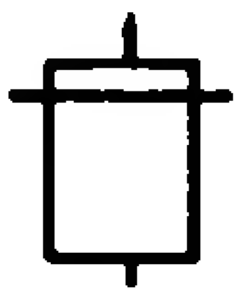


Pneumatic Controller

Humidifier

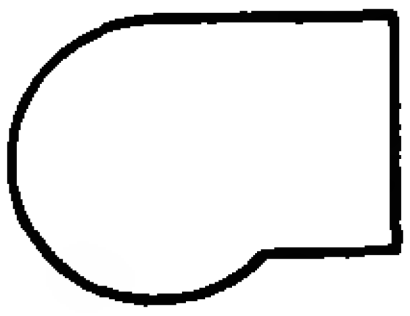


Vortex Damper



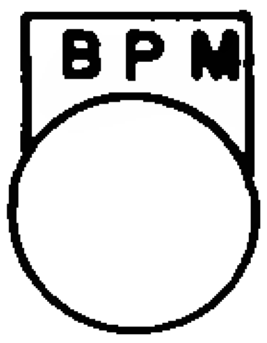
Damper Motor

Damper

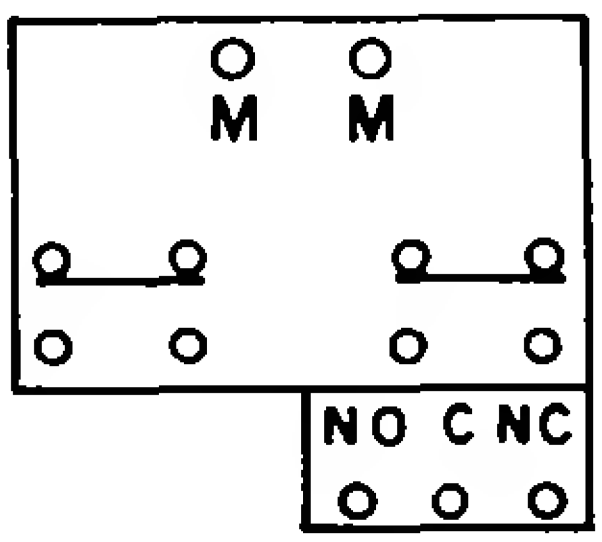


Fan

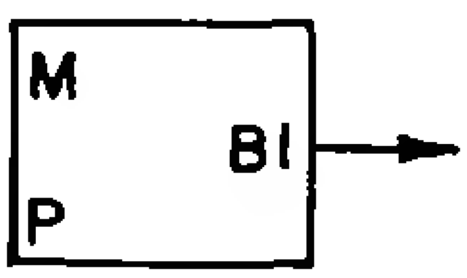
Pneumatic Restrictor



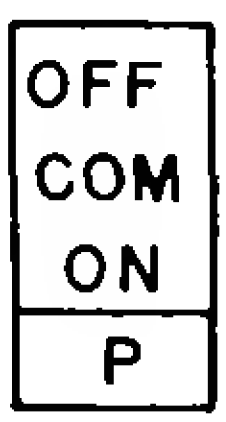
Pneumatic Proportional Relay



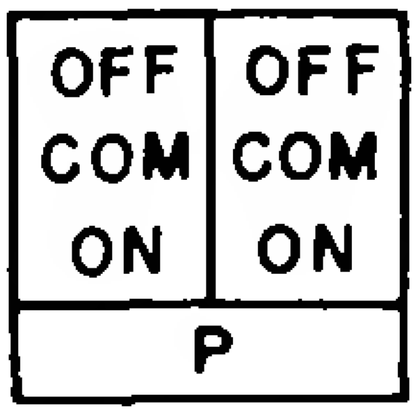
Time Delay Relay



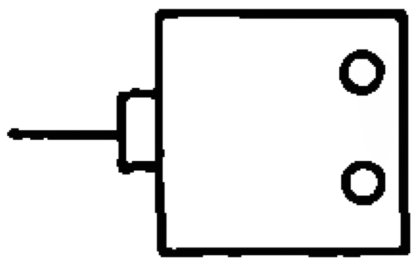
Pneumatic Selector Relay



Single-Pole, Double-Throw,
Pneumatic Switching Relay



Double-Pole, Double-Throw,
Pneumatic Switching Relay



Electro-Pneumatic Pressure Switch

Positive Side of Control Voltage

Negative Side of Control Voltage

Flow Switch

Single-Pole, Single-Throw,
Electrical Switch

PORT AUTHORITY SPECIFICATIONS AND CONTRACT DRAWINGS

Specification: WTC-502.00

Drawings Numbers:

Tower A	*Tower B*
M-A-13 thru M-A-22	M-B-13 thru M-B-22
M-A-26	M-B-26
M-A-41 thru M-A-45	M-B-41 thru M-B-45
M-A-73 thru M-A-77	M-B-73 thru M-B-77
M-A-104 thru M-A-106	M-B-104 thru M-B-106
M-A-116 thru M-A-158	M-B-116 thru M-B-158

Specification: WTC-511.00

SHOP DRAWINGS

Honeywell, Inc.
25-30 Stillman Avenue
Long Island City, New York 11101

Drawings Numbers:

998-500-A7-1 thru 998-500-A7-11

998-500-A41-1 thru 998-500-A41-8

998-500-A75-1 thru 998-500-A75-8

998-500-A108-1 thru 998-500-A108-9

998-500-ARH-10

998-500-BRH-10

998-500-B7-1 thru 998-500-B7-11

998-500-B41-1 thru 998-500-B41-8

998-500-B75-1 thru 998-500-B75-8

998-500-B108-1 thru 998-500-B108-9